N P S

R E S E A R C H

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THE SIGNAL ENHANCEMENT LABORATORY

Department of Electrical and Computer Engineering

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Background

In the 1970s, Adjunct Professor Stephen Jauregui and a student, LCDR Eugene Cummins, recognized that some aspects of the modernization of naval radio-receiving sites significantly degraded the ability of the sites to receive radio signals of primary interest. Professor Jauregui and LCDR Cummins organized a group of technical experts to investigate the reasons for this loss. This effort was conducted under the sponsorship of COMNAVSECGRU N-44. In the late 1970s Professor Jauregui and LCDR Cummins organized the Special Signals Laboratory of the Naval Postgraduate School to further investigate and define the receiving site problems. This informal effort evolved into the Navy's Signal-to-Noise Enhancement Program (SNEP) in 1985. Additional emphasis was provided to the program by the USA INSCOM for similar work at their sites.

Additional facility support grew as **Ray Vincent** and **Richard Adler** joined the laboratory and helped Professor Jauregui during field trips to Navy SIGINT sites and other related facilities. These professors taught several graduate courses unique in structure and content related to SIGINT operations. Each course examined new operational requirements along with field visits to investigate proposed solutions. Visiting lecturers, field trips, and company visits provided the classes with the background required to design and test effective and practical solutions to real problems. Project teams were formed to investigate and work on different approaches and solutions to practical problems. At the end of each course, each team presented their findings to facility members, other interested naval individuals, and industry experts. This industry and naval cooperation was expanded into annual SNEP progress review conferences, hosted by Professor Jauregui.

Upon the retirement of Professor Jauregui in 1993, the technical direction and leadership of the program at NPS passed on to Research Associate Professor Adler with support from Research Associate Ray Vincent. The program of the laboratory was expanded to include technical problems encountered by naval

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data-processing centers and continued as the Signal Enhancement Laboratory (SEL) of the Naval Postgraduate School.

Receiving Sites

SEL teams have participated in detailed investigations of signal-reception problems at 41 receiving sites located throughout the world. Included are site locations ranging from polar to equatorial regions on all continents and on many islands. The teams have identified a number of mechanisms and factors degrading signal reception along with the mitigation actions required to eliminate each individual mechanism or factor. This work is still actively underway with joint participation by NPS, other government entities, and industrial organizations. It has expanded to include work at sites operated by Canada and by other agencies.

Special SEL Quick-Reaction Teams have investigated and corrected several radio interference problems affecting the reception of signals at a number of sites ranging from VLF to microwave frequencies. These problems often prevent the operation of critical intelligence-collection related facilities until they are resolved.

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About the INVESTIGATORS

Richard W. Adler is an Associate Research Professor in the Department of Electrical and Computer Engineering. His undergraduate degree was received from Pennsylvania State University at University Park followed by a Master of Science in Electrical Engineering. Following graduation from Penn State, Dr. Adler worked as a research assistant at the Ohio State University Antenna Lab where he began his doctoral studies. Several industry positions followed. As part of the technical staff of Hughes Aircraft, he worked on the development of frequency-scan radar antennas. At Ford Aeronutronics, he contributed to missile range safety studies for the Pacific Missile Range at Point Mugu. He later returned to Penn State as an instructor and received his Ph.D. Dr. Adler joined the faculty at NPS in 1969.

His research interests include antenna performance and propagation prediction validation measurements in a littoral environment; techniques for the location and mitigation of power-line noise sources and mitigation of RF noise from digital data systems, electronic light ballast and electronic motor-controller systems; and prediction and measurement of HF-microwave radiation hazards for communication and broadcast antenna sites. Teaching interests focus on antennas and propagation, electromagnetics, SIGINT, computational electromagnetic modeling and electromagnetic environmental effects.

Wilbur R. Vincent is a Research Associate in the Department of Electrical and Computer Engineering. Mr. Vincent received the B.S. and M.S. degrees in Electrical Engineering from Michigan State University. Following graduation, Mr. Vincent worked for Bell Aircraft Corporation as a research engineer developing missile guidance and long-range radar-tracking systems. He later joined the staff of the Stanford Research Institute (now known as SRI International). While there he organized the Communications Research Laboratory. He also worked for Develco Inc. of Sunnyvale, CA, Systems Control of Palo Alto, CA, and once again with SRI International as a staff member of the Radio Physics Laboratory. He joined NPS on a part-time basis as a Research Associate of Electrical Engineering in 1979.

Mr. Vincent's fields of specialization include the measurement and analysis of the time-and-frequency-domain properties of signal structures. Emphasis has been given to improving our understanding of the properties of time-varying signals and noise that are difficult to describe and understand with conventional stationary analysis descriptors and techniques. Mr. Vincent is the author of several hundred technical publications and papers. He is a member of the IEEE and several of its technical societies, has been a member of several advisory boards for government and industry, and has participated in several special teams to assist in the planning and design of telecommunications systems for developing countries.

SIGNAL ENHANCEMENT LAB, *continued from page 2*

Techniques have been developed to define and analyze the temporal and spectral characteristics of non-stationary signals and non-stationary noise as well as the more familiar stationary signal and noise concepts defined in standard texts. Techniques have been developed to evaluate and quantify the impact of each individual factor on signal reception. This allows site managers to implement the most effective mitigation actions and delay those of little importance.

A large collection has been gathered of the detailed temporal and spectral properties of various signals and noise from a variety of sources. This collection is a valuable asset during surveys at a new site and during ongoing surveys after the modification and updating of an older site. This collection provides a means to rapidly identify the source of a number of radio-noise and radio-interference problems. Over 200 unclassified theses, 50 classified theses, and 150 technical reports have been produced by the students, staff, and faculty members associated with the laboratory.

To measure signals out in the field, a diesel powered van equipped with a 30 MHz whip, a 140 MHz antenna, several communication antennas, and a trailer with a diesel-powered generator equipped with a disc cone antenna, are used by the SEL staff.

Data-Processing Centers

The transition of naval data-processing centers from the use of outdated teletype and mechanical equipment to computer-based equipment has provided a vast improvement in the operation and capability of such centers. It has also created a number of unique analog and digital signal-transmission problems. These include signal-corruption from outmoded installation practices, building power-distribution problems, the use of noise-producing devices, misguided grounding practices, the provision and use of outmoded installation and equipment handbooks and standards, and the widespread lack of valid installation and equipment standards.

SEL teams have worked at the USN Kunia Regional Security Operations Center, the USA INSCOM Fort Gordon Security Operations Center, and at a number of smaller centers. Solutions have been devised for a number of problems including the identification of signal-corruption mechanisms, the identification and correction of noise-producing devices such as modern Uninterruptible Power Supplies (UPS), variable-speed motor controllers, poorly-designed switching-power supplies, and sources of intermittent transients. All of these can and do disrupt the operation of digital data-processing devices.

Antenna Performance Predictions

The SEL supports Navy requirements for antenna performance predictions via numerical modeling of antenna systems in the presence of terrain and platform interactions. Conventional classroom and textbook techniques for calculating antenna patterns do not apply when the antennas are mounted on platforms or in irregular terrain. Since the early ‘70s, SEL staff members have been involved in a tri-service program of developing and validating computer-based numerical modeling techniques for shipboard and landbased antenna performance.

Cooperative efforts with Visiting Associate Professor **Jovan Lebaric** in developing electromagnetic (EM) modeling techniques and tools to support the airborne electronic warfare (EW) community have paid off. A simple, yet powerful technique, based on eigen analysis has

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CENTER FOR INFORMATION SYSTEMS SECURITY STUDIES AND RESEARCH

Assistant Professor Cynthia Irvine, Center Director
Department of Computer Science

The security of networked systems of computers is essential for national security. The Naval Postgraduate School is fortunate to be the home to what many researchers in the computer and network security community consider to be the preeminent program in the United States combining research and studies in information systems security (INFOSEC) and information assurance (IA). Since its inception, the Naval Postgraduate School Center for Information Systems Security Studies and Research (NPS CISR) has fostered an environment in which faculty, staff, and students work together to understand the information assurance requirements of DoD and to address the challenges presented by those requirements through careful analysis and research.

The need for focussed effort in information security and assurance is evident. The development of military strategy and tactics for warfare in the information age is of growing importance and has, as its principal objective, information superiority for U.S. forces engaged in battle on land, at sea or in the air. A key aspect of achieving information superiority is the protection of critical national information assets. Increasingly, military systems are dependent upon the national infrastructure for critical services. Today the United States faces an enormous problem. All aspects of the national infrastructure, from telecommunications to health care and from air traffic control to power systems, depend upon the correct operation of computers and networks. The security of those networks is crucial to the health of that infrastructure, yet security is often ignored as a fundamental requirement. Providing adequate protection for these information assets is a concern for the U.S. military and presents many new scientific and technical challenges in the area of INFOSEC and IA.

The October 1997 report of the Presidential Commission on Critical Infrastructure Protection (PCCIP) recommends, "*education on methods of reducing vulnerabilities and responding to attacks on critical infrastructures, …programs for curriculum development at the undergraduate and graduate levels in resilient system design practices,"* and efforts to make the "*required skill set much broader and deeper in educational level [for] computer scientists, network engineers, electronics engineers, [and] business process engineers."*

Anticipating these recommendations by more than five years, NPS, with support from the National Security Agency (NSA), initiated a modest effort within the Computer Science Department to build a prototype program with three objectives: the development of courses on computer and network security based in a strong curriculum of science and engineering; research in information system security; and development of a cadre of officer-graduates with a thorough understanding of computer and network security

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About the DIRECTOR

Cynthia Irvine is an Assistant Professor in the Department of Computer Science. Prior to joining the faculty at NPS in 1994, she worked at Gemini Computers on several projects to utilize Class A1 technology for applications ranging from file systems to messaging prototypes. She received her undergraduate and Ph.D. degrees from Rice University and Case Western Reserve University, respectively. She has participated in the development and review of several interpretations of and guidelines for the Trusted Computer System Evaluation Criteria and has provided critical comments on emerging standards for the evaluation of trusted systems. Her current research and teaching interests are in the area of network security architectures and high assurance multilevel distributed systems.

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Center Director, Cynthia Irvine, joins students, LT Susan Bryer Joyner, LT Scott Heller and Capt Jason Hackerson, in the Computer Security Lab.

issues. An essential notion behind the development of NPS CISR is that the security of information systems must be founded on scientific and engineering principles which are used to construct secure systems rather than to discover after deployment that systems are inadequate.

Within a few years, the success of these early efforts was clear. Hundreds of students were attending the flagship course and there was considerable interest in research. In response, an expansion of the program began and in the fall of 1994 the NPS Academic Council approved the addition of a sequence of new courses to the Computer Science curriculum: Secure Management of Systems; Network Security; Secure Systems; Security Policies, Models and Formal Methods; and Database Security. Combined with the NPS thesis requirement for all Masters-level students, the academic program provides graduates with the knowledge needed to manage and contribute to engineering teams tasked not only to design and build secure systems, but also to configure and maintain them. The strong science and engineering education of NPS CISR graduates helps them to address new problems and to distinguish "snake oil" and marketing hyperbole from credible security solutions.

NPS CISR serves DoD in eight primary areas:

Curriculum. The explosive growth of information systems has resulted in rapidly changing technologies and challenges in computer security. Curriculum development ensures a timely, coherent and comprehensive program in INFOSEC foundations and technology.

Laboratory. Development of the Computer Security Laboratory has supported all aspects of the NPS CISR effort. Because major commercial vendors do not build systems and software that can be relied upon to protect sensitive information, security architectures including a mixture of both popular products and those specialized for computer security are found in the laboratory. The NPS CISR laboratory has supported over 250 students in work on assignments and laboratory exercises during the past year. Used for a variety of research projects, the facilities enable participants to explore the hardware and software available to solve current computer security problems and to consider potential future architectures and technologies.

Faculty. NPS CISR has an active program to increase the sophistication of faculty in INFOSEC concepts and to involve interested faculty members in leading-edge INFOSEC research problems. The results have been not only an increased appreciation of the foundations of computer security but a heightened understanding of the need to consider security throughout the entire process of design and development of systems. Several successful research efforts have been launched or assisted as a result of the faculty development effort.

Visiting Professors. The Visiting Professor program brings computer and network security experts to NPS to

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COLLABORATIVE RELATIONSHIPS WITH TENANT COMMANDS ENHANCE RESEARCH AND EDUCATION AT NPS

The Naval Postgraduate School hosts several tenant commands at its site in Monterey, California. The co-location provides an opportunity for collaborative efforts which benefit both host and tenant.

The Naval Research Laboratory's (NRL) Marine Meteorology Division evolved from the Naval Environmental Prediction Research Facility (NEPRF) located in Monterey. In 1989, NEPRF merged with the Naval Oceanography Research and Development Activity (NORDA) to form the Naval Ocean and Atmospheric Research Laboratory (NOARL), a corporate laboratory under the sponsorship of the Office of Naval Research. In 1992, as a continuation of the Department of Defense laboratory consolidation effort, NOARL was incorporated into the Naval Research Laboratory (NRL) and became part of the newly formed Ocean and Atmospheric Science and Technology Directorate.

Naval Research Laboratory - Marine Meteorology Division: To conduct a research and development program designed to improve our basic understanding of atmospheric processes that impact Fleet operations and to develop systems that analyze, simulate, predict, and interpret the structure and behavior of these models.

Fleet Numerical Meteorology and Oceanography Center: To combine innovative technology with the best available science in order to provide the best weather and oceanographic products, data and services to the operating and support forces of the DoD anywhere, anytime.

Training and Doctrine Command Analysis Center - Monterey: Provide credible and relevant research to advance Army warfighting doctrine, training and analysis.

Naval Postgraduate School: Increase the combat effectiveness of U.S. and Allied armed forces and enhance the security of the U.S. through advanced education and research programs focused on the technical, analytical, and managerial tools needed to confront defense related challenges of the future.

The Marine Meteorology Division (NRL-MRY) conducts basic and applied research in the atmospheric sciences. Basic research includes work in air-sea interaction process studies, orographically forced flows, atmospheric predictability, and aerosols. Applied research spans the gamut from development of both central-site and on-scene analysis/forecast systems, to tactical decision aids for operations or weapons systems support. Specialties of the Division include numerical weather prediction, data assimilation and quality control, coupled air-ocean models, marine boundary layer processes, atmospheric physics, remotely sensed data interpretation and application, environmental decision aids, atmospheric effects on Naval systems, and database management. The Division employs over 50 advanced-degree research scientists and about 15 military and administrative support personnel.

During the past two years, collaborative research efforts involving NPS faculty from the Department of Meteorology and NRL scientists include: Professor **Phil Durkee**'s Coastal Aerosol Characterization project which combines model and observational results to test models and investigate initialization schemes (Dr. Douglas Westphal, NRL collaborator); Research Assistant Professor **Tim Li** and Professor **C.P. Chang**'s study of the coupled atmosphere-ocean-land system on tropic and global climate (Dr. Tim Homand and Dr. Rich Hodur, NRL collaborators); Research Assistant Professor **Tom Murphree**'s

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work on tropical cyclones, tropical air-sea interaction, El Niño and La Niña events, and teleconnections (Dr. Ron Gelaro, Dr. Carolyn Reynolds, and Dr. Jim Goerss, NRL collaborators); Distinguished Professor **Russ Elsberry**, Research Associate Professor **Lester Carr** and Research Associate Professor **Pat Harr**'s study of the physical processes associated with extra-tropical transition of tropical storms (Dr. James Goerss, Mr. Jeff Hawkins, and Mr. Buck Sampson, NRL collaborators); Professor **R. T. Williams**' projects on evaluating the mechanisms that cause change in tropical cyclone structures and improving the COAMPS-based simulation of mesoscale phenomena over topography with boundary layer effects (Dr. Melinda Peng, NRL collaborator); Assistant Professor **Qing Wang**'s numerical modeling of turbulence-aerosol-cloud interaction (Dr. Doug Westphal and Dr. Andy Goroch, NRL collaborators); Professor **Kenneth Davidson** and **Chuck Wash**'s evaluation of shipboard METOC measurement requirements and commercial-off-the-shelf equipment available to meet them (Dr. Andy Goroch, NRL collaborator); Associate Research Professor **Pat Pauley**'s case studies of the ability of the Navy's mesoscale data assimilation to depict mesoscale phenomena (Dr. Ed Barker, NRL collaborator), and Professor Wash's study of the COAMPS (Coupled Ocean/Atmospheric Mesoscale Prediction System) model to forecast synoptic and mesoscale features in the Persian Gulf during various intensive observation periods (John Cook, NRL collaborator).

Collaborative research efforts produce joint papers, conference presentations and student theses topics. NPS faculty and NRL scientists often co-advise NPS students. Having a "research source" such as NRL so close to NPS allows incorporation of the latest meteorological developments into the course work of the METOC students. For example, NRL developed the Navy's new high-resolution regional mesoscale forecast system, COAMPS, and students at NPS have the opportunity to learn about this model first-hand. Having a specialized education source such as NPS so close to NRL also has its benefits. NRL scientists have pursued advanced-level degrees as well as taken continuing education classes at NPS where there is the added benefit of curricula tailored to Navy's needs.

Faculty and students at NPS not only have access to the Navy's only laboratory dedicated to meteorological research, they have the added benefit of an operational processing center. Co-located with NRL-MRY is the Fleet Numerical Meteorology and Oceanography Center (FNMOC). FNMOC is the principal Department of Defense (DoD) operational processing center for automated METOC analyses and predictions. It is one of a half-dozen internationally recognized operational centers for global and regional atmospherical models, and is widely acclaimed as the world's leader in performing global oceanographic and coupled air-ocean modeling operationally.

With a workforce of almost 300 military and civilians, FNMOC operates 24 hours a day, 365 days a year. Exploiting supercomputer power, the world's most complete database of oceanographic and atmospheric observations is assimilated several times daily into sophisticated global and regional METOC models, many of which were developed by NRL. These models treat the coupled air-ocean environment as a totally integrated

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Professor **Richard Franke** of the Department of Mathematics spent his sabbatical at NRL this past year working on problems of data assimilation. The preferred process used to incorporate measured weather data into the numerical prediction system is a statistical method. It relies on making a good estimate of statistical properties, in particular the spatial covariance of the prediction errors and the variance of the observation errors. In three dimensions this specification poses a problem because the empirical errors are not isotropic. To fit the empirical data, it is desired to have some functions that have some free parameters, with enough freedom to obtain a reasonably good fit. Professor Franke's investigation found a method that involved a simultaneous transformation of independent variables and fitting the data that provides more accurate functions than those currently used, with the added advantage they are easier to use and meet all necessary mathematical conditions. The results of his work are being published in two NRL technical reports, *Three Dimensional Covariance Functions: Theory* (NRL Report No. NRL/MR/7531-97-7231) and *Three Dimensional Covariance Function: Real Data* (NRL Report No. NRL/MR/7531-97-7232).

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system from the top of the atmosphere to the bottom of the ocean, placing special emphasis on the air-ocean interface. Resulting products include oceanic and atmospheric analyses and forecasts and related data sets projected out to a week and beyond. These products are then distributed to regional centers and are also made available through direct access to DoD activities worldwide via dial-up systems and Internet technology.

Customers to FNMOC products are primarily Navy and Marine Corps forecast sites and deployed units and ships, but also encompass forecast activities worldwide from all services. Increasingly, the Air Force Weather Agency has become a major customer under recent Navy-Air Force agreements. Other customers include a variety of Joint Operating Forces, command and control activities, other DoD activities, and a whole spectrum of federal agencies. As of late 1997, the worldwide customer base was comprised of over 800 military forecast sites and DoD support laboratories In addition, the remainder of the Federal government and civilian customers are able to access weather and ocean analyses generated at FNMOC in real-time via the National Weather Service.

Co-location with NRL-MRY has significantly streamlined the process of transitioning numerical models from the research and development stage to the operational environment. NRL-MRY has developed and transitioned to FNMOC the global and mesoscale atmospheric analysis/

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TROPICAL CYCLONES

Distinguished Professor Russell Elsberry, Research Associate Professor Patrick Harr, and Research Associate Professor Lester Carr
Department of Meteorology

An active collaboration is ongoing between NPS Professors Elsberry, Carr, and Harr and NRL-Monterey in the area of tropical cyclone-related research. This collaborative effort has facilitated the rapid transfer of research results to the operational Joint Typhoon Warning Center (JTWC) in Guam.

Professor Elsberry and Jeff Hawkins and Jim Goerss of NRL are completing a study of the impact of new surface wind observations from a space-based scatterometer called NSCAT. This project, which is sponsored by the NASA Jet Propulsion Lab, validates the winds in the regions of tropical cyclones and their impact on predictions by the Navy global atmospheric prediction model. These observations were the basic materials for a recently completed M.S. thesis by Capt Scott Magnan (USAF).

Jeff Hawkins of NRL has also provided microwave data from the Defense Meteorological Satellite Program in the region of tropical cyclones. Professors Harr and Elsberry have been using these observations to track mesoscale convective systems that are hypothesized to contribute to tropical cyclone formation in special conditions. LT Dave Milot (USN) recently completed his M. S. thesis based on these observations and future collaboration is planned.

Jim Goerss of NRL and Professors Carr and Elsberry have initiated a new project to improve the initial condition specification of tropical cyclones in the Fleet Numerical Meteorology and Oceanography Center (FNMOC) global model. A wind field model developed at NPS will be implemented and tested by NRL to demonstrate improved track predictions in the global model, which provides the primary guidance to Joint Typhoon Warning Center forecasters.

Buck Sampson and Jim Goerss of NRL and Mary Alice Rennick of FNMOC have provided post-storm observations, analyses, and predictions that Professors Carr and Elsberry have used in developing and testing the Systematic Approach to tropical cyclone track forecasting. Two recent M. S. theses by LCDR Greg Ulses and LCDR Rob Schnabel have utilized these data sets. The Ulses thesis resulted in a technique that improved the 12-h FNMOC track forecast by more than 50% in a test sample. The Schnabel thesis compared two FNMOC models and documented six situations in which either one or both may be expected to have significant errors. Such information is useful to the JTWC forecasters in knowing when to rely on the FNMOC guidance.

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forecast models that form the backbone of the Navy's worldwide weather forecasting capability. Some of the models utilized by FNMOC and developed by NRL include the Navy Operational Global Atmospheric Prediction System (NOGAPS), the Navy Operational Regional Atmospheric Prediction System (NORAPS), and the Coupled Ocean/Atmospheric Mesoscale Prediction System (COAMPS).

Whereas NPS students and faculty receive obvious benefits by the proximity of the "conduit for the Navy's global ocean and atmospheric" data, the benefit is returned when identifiable applied research needs of FNMOC become the subject of a master's thesis. For example, in the early 90s, a thesis project resulted in the development of the first operational capability for remote sites to download satellite imagery to a PC over regular telephone lines. The results of the thesis were placed into worldwide distribution before the thesis itself was formally distributed.

In recent years, the National Weather Service has relocated several of their Weather Forecast Offices (WFOs) to locations where there are hubs of academic and government meteorological activity. One of the WFOs selected for relocation was the Redwood City, California, office. In 1994, this WFO was moved to Monterey to establish a closer association with the NPS Departments of Meteorology and Oceanography, NRL Marine Meteorology Division and FNMOC. The primary function of the Monterey WFO is to forecast weather and coastal wave conditions and issue warnings within its area of responsibility (Central and Northern California). The WFO has access to Navy analyses, forecasts and satellite data products and provides feedback to NRL and FNMOC on the performance of those products for the West Coast. At NPS, students in weather forecasting classes take field trips to the WFO and are able to view operational forecasting first-hand and have their questions answered by local forecasters.

Co-location of NRL-MRY, FNMOC and NWS with NPS makes Monterey one of the premier meteorological and oceanographic research centers

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QUALITY CONTROL OF OPERATIONAL AIRCRAFT OBSERVATIONS

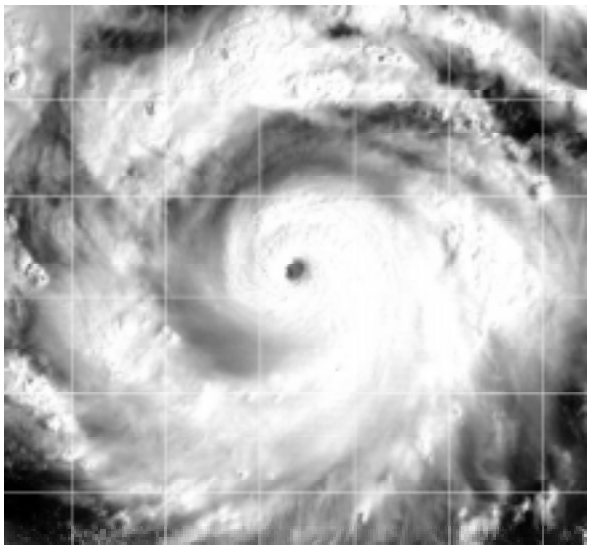
Research Associate Professor Patricia Pauley
Department of Meteorology

New algorithms for detecting errors in atmospheric observations made by instrumented aircraft are being developed. These observations are taken either automatically or manually on commercial aircraft worldwide, and are disseminated to the numerical weather prediction centers, such as FNMOC. The number of aircraft observations has increased dramatically over the past ten years as automated meteorological observations (temperature and winds at specific times, positions, altitudes) from the ACARS (ARINC [Aeronautical Research, Inc.] Communications, Addressing, and Reporting System) have become available in increasing numbers. Observations are taken at intervals of 300' to 2000' during ascent and descent, and at intervals of 5-8 minutes during level flight. Currently there are approximately 35,000 observations available globally per day, with heavy concentrations of data near busy airport hubs and along major flight paths. These observations are of similar accuracy to those from balloon-borne rawinsondes, the workhorses of the global observational network, and they have a relatively small error rate, typically about 2%. However, some of the errors are sufficiently egregious that they would negatively impact the numerical forecasts that use the initial conditions provided by the data assimilation system, hence the need for careful quality control.

Initial involvement between Dr. Pauley and Dr. Barker (NRL) began with a joint effort to compare upper-level fronts, as revealed by aircraft data, to the same fronts as depicted by the Navy Operational Regional Atmospheric Prediction System (NORAPS) analyses. Dr. Pauley developed quality control algorithms to exclude erroneous observations from a two-month dataset that was used in this study, which LT Edward Stephens, USN, worked on for his M.S. thesis research at NPS.

The quality control algorithms now being developed for the aircraft data are part of the Navy's next generation data assimilation system. Eventually, this system will be transitioned from NRL to operational use at FNMOC, where it will provide initial conditions for the numerical weather prediction models that provide weather forecast guidance for the fleet.

COLLABORATIONS, *continued from page 9*



Hurricane Linda

of the world and benefits all involved.

NPS is also host to an Army research center called the U.S. Army Training and Doctrine Command (TRADOC) Analysis Center (TRAC)-Monterey. TRAC-Monterey provides a permanent Army presence on campus with a research program primarily focused on advanced computer simulations. TRAC-Monterey is one of five centers located throughout the United States. TRAC is headquartered at Fort Leavenworth, Kansas, and directed by Mr. Michael F. Bauman. The other TRAC elements are TRAC-Fort Leavenworth, Kansas, TRAC-White Sands Missile Range, New Mexico, and TRAC-Fort Lee, Virginia. TRAC-Monterey is currently directed by LTC Michael L. McGinnis.

TRAC-Monterey was established in December 1980 following a conversation between Operations Research Professor **Sam Parry** and the Commanding General of TRADOC, General Donald Starry. Professor Parry suggested the possible assignment of an Army faculty billet at NPS to help out with theses advising and teaching. General Starry directed the TRADOC Chief of Staff, Major General John B. Blount, to establish TRAC-Monterey. Initially staffed by NPS graduates, TRAC-Monterey supported research activities of Army students attending NPS. Today, TRAC-Monterey serves as TRAC's research center for advanced distributed computer simulations. The major research thrusts in this area include high-level computer simulations and advanced simulation technologies for modeling military operations in distributed environments. The analysts assigned to TRAC-Monterey also accomplish practical, real-world military operations research for the Army.

TRAC-Monterey remains closely linked with the Army through a strong research program that involves military analysts, NPS professors, NPS students and contractors. The research program provides Army officers assigned to TRAC-Monterey from the FA49 community and NPS students with professional development opportunities that enhance their skills, knowledge and experiences as both military officers and operations research analysts.

TRAC-Monterey's research program offers NPS faculty a broad range of opportunities for studying applied problems that support NPS curricula and enhance professional development. Recent NPS faculty research efforts sponsored by TRAC-Monterey include the following: Department of Computer Science Research Assistant Professor **Wolfgang Baer**'s development of generalized, world-wide high resolution terrain databases and database conversion tools to support the creation of databases for simulations and wargames; Department of Operations Research Visiting Assistant Professor **Arnold Buss**' research on a simulation object models and object standards for high resolution land combat models; Department of Mechanical Engineering Professor **Morris Driels**' study, assessment and classification of U.S. Army target acquisition models for the recently published Target Acquisition Handbook; Department of Operations Research Distinguished Professor **Donald Gaver** and Professor **Patricia Jacobs**' development of high-level models

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Research Assistant Professor **Wolfgang Baer**, Department of Computer Science, working with the TRAC-MTRY and TEXCOM at Fort Hood, Texas, in the area of realistic battlefield measurement and replication, has recently developed a low cost line-of-sight (LOS) server and video realistic perspective view generator (PVG). LOS and PVG are used for engagement analysis, after action review systems, and operational test support. The functionality was transferred from SGI and Transputer based parallel processing machines costing between $200 to $300 thousand dollars several years ago to a low cost off-the-shelf quad Pentium device. By taking advantage of the Microsoft game technology interface for rapid image display the performance was actually improved as compared with the older and much more expensive devices. The new server will be demonstrated at the Military Operations Research Society Conference on June 23, 1998, at NPS. The system is scheduled to calculate LOS in the Rotary Pilots Associate test of helicopter vs. ground force engagements at Yuma Proving Grounds this Fall.

COLLABORATIONS, *continued from page 10*

for performing parametric sensitivity analyses of suitable methods of evaluation for Army forces equipped with Crusader, the Army's new artillery system; Professors Gaver and Jacobs' work on development of a new methodology for quantifying and modeling information uncertainty using deterministic combat simulations such as VIC, Eagle and AWARS; Department of Computer Science Associate Professor **Neil Rowe**'s investigation of using artificial intelligence to simplify the integration of diverse terrain databases in modeling and simulation; and Department of Computer Science Professor **Luqi**'s research to develop a software architecture to support re-engineering of the Janus Combat Simulation.

TRAC-Monterey's research program supports students from all branches of military service with opportunities to investigate a wide range of interdisciplinary issues. TRAC's research program is particularly well suited to military officers who wish to apply the operations research, applied mathematics, engineering and computer science concepts studied in the classroom to solving real-world military problems. TRAC-Monterey analysts support student projects, masters theses and student experience tours. TRAC personnel also serve as advisers or co-advisers on student theses.

TRAC-Monterey welcomes the opportunity to collaborate on service-related projects with faculty from all NPS Departments and students from all branches of military service. TRAC-Monterey is located at NPS to provide military officers attending NPS with real-world projects that are well suited for either thesis work or course projects. This in turn provides DoD agencies with a greater range of expertise to address a wide spectrum of real-world problems and projects. In summary, the presence of TRAC on campus, as with NRL and FNMOC, provides NPS with an important source of expertise within the domain, and as with NRL and FNMOC, NPS provides TRAC analysts with a ready source of continuing education opportunities.

MODULAR SOFTWARE ARCHITECTURE OF THE JANUS COMBAT SIMULATION

Luqi, Principal Investigator
Department of Computer Science

Janus is a software-based war game which simulates ground battles between two adversaries. It is an interactive six-sided, closed, stochastic, ground combat simulation that features precise color graphics. Janus is "interactive" in that command and control functions are entered by military analysts who decide what to do in crucial situations during simulated combat. The current version of Janus operates on a Hewlett Packard workstation and consists of a large number of FORTRAN modules, organized as a flat structure and interconnected with one another via FORTRAN COMMON declarations, resulting in a software structure that makes modification to Janus very costly and error-prone. There is a need to modernize the Janus software into a maintainable and evolvable software, and to take advantage of modern Personal Computers to make Janus more accessible to the Army.

The Software Engineering Group in the Department of Computer Science is currently working with TRAC-Monterey to extract the existing functionalities through reverse engineering and then produce an object-oriented architecture that captures the existing and enhanced Janus functionalists. This is the first step to re-engineer Janus into an object-oriented software system that is written in the C++ programming language and operates on Personal Computers.

The reverse engineering phase of the project was carried out by a team of three software engineering students, **CPT Julian R. Williams**, USA, **CPT Mark L. Marrell**, USA, and **LTJG Ilker Duranlioglu**, Turkish Navy, under the guidance of a Software Engineering professor. The students spent the first week familiarizing themselves with the Janus software. The next two months were spent studying the existing FORTRAN codes, software design manuals, database manager manuals, and Janus user manuals in order to extract the communication structures from the old code and embody the structures in a clean high level Prototype System Description Language (PSDL) using the Computer-Aided Prototyping System (CAPS) developed at the Naval Postgraduate School. Based on the PSDL description, the students proceeded to reorganize the Janus software into a modular hierarchical software architecture. The data and operations were redesigned to take advantage the object-oriented technology. New modules are being added to capture the enhanced functionalists.

The availability of the CAPS editors and translators allows the re-engineering team to rapidly modify the architecture and experiment with different designs. The CAPS translator and scheduler automates the syntactic and semantic verification process to maintain the correctness of the architecture.

NPS TO PARTICIPATE IN DoD SBIR PROGRAM

The Navy's Small Business Innovative Research (SBIR) Program focuses on science and technology that enhance the Navy's capabilities. It is directed at funding dual-use technologies, anticipating that the products of each SBIR R&D effort will be useful to both the military and the private sector. The SBIR Program provides an opportunity for small high technology firms (500 people or less) to develop solutions to Navy science and technology needs.

Thanks to the efforts of **Bob Bluth**, Director of the Center for Interdisciplinary Remotely Piloted Aircraft Studies (CIRPAS), NPS was selected to participate in the Navy's SBIR Program. In this program, NPS will have the opportunity to submit three candidate topics each year, act as a technical point-of-contact during the solicitation process and throughout any subsequent award(s). POCs will review resulting proposals within three weeks after the proposal deadline (14 Jan 99), award at least one Phase I and possibly a Phase II contract per topic, monitor their technical performance, and plan follow-on R&D as required. SBIR Phase I awards are limited to $70k over six months with a $30k option over three months. SBIR Phase II awards are limited to $600k over two years typically with a $150K 6-month "bridge" option.

The NPS SBIR Program is intended to take advantage of the school's unique faculty and student experience in Navy science and technology. To this end, all departments and academic groups at NPS have been encouraged to submit concept topics. The NPS SBIR Review Board met in mid-May to review the submissions and select three to be forwarded to the Navy SBIR Program Office. NPS topics that are approved by the Navy SBIR Program Office and the DDR&E will be included in the 99.1 DoD SBIR solicitation scheduled for release on 1 December 1998. Potential bidders will be authorized to interact with topic authors and technical POCs during the presolicitation announcement period. (http://www.onr.navy.mil/sci_tech/industrial/sbir_bbs/)

MILITARY ACADEMIC RESEARCH ASSOCIATE PROGRAM ESTABLISHED WITH LAWRENCE LIVERMORE NATIONAL LABORATORY

A Memorandum of Agreement was recently entered into with the Lawrence Livermore National Laboratory (LLNL) to establish the Military Academic Research Associate (MARA) Program. The Program is a cooperative program whereby graduate students and/or faculty are temporarily assigned to LLNL. Participants are typically assigned for a period of four to six weeks to perform research related to DoD interests and to broaden their knowledge of LLNL's technical capabilities.

This program is intended to provide selected students and faculty with scientific laboratory experience and research opportunities in disciplines and technologies of mutual interest to the DoD and LLNL. It is designed to benefit the students, the DoD, and LLNL by enhancing the education and training of the participants and stimulating interaction between academic personnel and LLNL technical staff. Faculty are also encouraged to participate in an effort to strengthen research knowledge and cooperation, to obtain new material for the development of curriculum, and possibly facilitate collaborative research.

The Associate Provost and Dean of Research is the NPS point-of-contact and will be responsible for selection and nomination of qualified students, graduates and faculty.

NPS PARTICIPATES IN LECTURE SERIES ON HUMANITARIAN ASSISTANCE AND DISASTER RELIEF

The Center of Excellence in Disaster Management and Humanitarian Assistance in conjunction with the University of Hawaii, USPACOM J56, and the Naval Postgraduate School presents a lecture series on "Information Issues in Disaster Operations." This series is a continuation of the "Operational Research for 21st Century Missions" lectures. Current lectures will highlight the changing information requirements for humanitarian assistance and disaster relief (HA/DR). It will bring together practitioners with insights and the operational and academic communities for formal presentations and informal discussions of exercises and real-world event analyses.

Professor **Michael Sovereign**, former Director of the Institute for Joint Warfare Analysis, is currently on temporary assignment with USPACOM J56.

NPS FACILITY WILL BE SITE OF TRAINING FOR COMPREHENSIVE NUCLEAR TEST BAN TREATY ORGANIZATION PERSONNEL

The Deputy of the Nuclear Treaty Programs Office of the Assistant Secretary of Defense, Ralph W. Alewine, III, recently requested the Naval Postgraduate School's assistance, on behalf of the U.S. government, in carrying out a training program in support of implementing the Comprehensive Nuclear Test Ban Treaty (CTBT), which was signed by the President in September 1996. The initial request came from the Comprehensive Test Ban Treaty Organization (CTBTO) which has been created in Vienna, Austria, to implement the provisions of the Treaty.

"The unclassified Point Sur hydrophone has already proved to be a crucial station for the development of the treaty monitoring system as well as for the testing and evaluation of the hydroacoustic signal processing technology which will be used by the DoD in verifying the treaty."

Ralph W. Alewine III
Deputy of the Nuclear Treaty Programs Office
Assistant Secretary of Defense

The verification regime for the CTBT calls for the establishment of a global monitoring network of stations, including hydroacoustic sensors, sending real-time data to an International Data Center (IDC) in Vienna. As part of the implementation process, the CTBTO has requested that the U.S. conduct a technical training course for operators of the hydroacoustic segment of the monitoring system. The training will take place at the Ocean Acoustic Observatory (OAO) at Point Sur that has been developed and maintained by the Coastal Ocean Acoustic Center (COACt). The OAO was specifically requested as the site for the training because it is currently sending data to the prototype IDC in Arlington, VA, and is being operated by NPS staff. The location of the OAO is also far more logistically favorable than the other two operating hydroacoustic sites at Wake and Ascension Islands.

Mr. Alewine further stated that, "The unclassified Point Sur hydrophone has already proved to be a crucial station for the development of the treaty monitoring system as well as for the testing and evaluation of the hydroacoustic signal processing technology which will be used by the DoD in verifying the treaty. The conduct of this training by the NPS will make another significant contribution toward the establishment of an effective verification regime by the U.S. Government."

The Ocean Acoustic Observatory (OAO), located at Point Sur, has been developed and maintained by the NPS Coastal Ocean Acoustic Center (COACt).

GUNWORKS: OPERATIONAL SUPPORT TO THE FLEET FOR THE 5" GUN WEAPON SYSTEM

Research Assistant Professor Alexander J. Callahan, Project Leader
Institute for Joint Warfare Analysis

There has not been a system proponent of the 5"/54 MK45 Gun Weapon System (GWS). As a result some argue that this is the reason the GWS has not enjoyed the level of attention required to improve design, utilization and become integrated into the Combat System. To establish the importance of the gun system in the present as well as the future, NSWC-Crane Division and NPS began evaluating GWS issues.

There are some interesting and valid questions to be answered while contemplating the current state of gunnery and the evolution of Naval Warfare. What reliability of ammunition components do we need for the fleet to fulfill its mission in gunnery? How many rounds of each type should we load into our 5"/54 magazine? How accurate is the gun? Does the Global Positioning Satellite System (GPS) improve accuracy? Should ships continue to have guns? What ammunition is required to support the marines in expeditionary warfare? How will a longer range for the gun affect the battle space? Is a solid payload for a 5" projectile required? Will guns help keep the budget down and save the more exotic weapons for the more exotic targets? Can the erosion of knowledge of gun weapon system operation and tactics be reversed through onboard training? How will the 5" gun be utilized in network centric warfare?

NPS became involved in support of the fleet and the gun system through the initiative of Mr. Larry Massa, PM413 at NSWC Crane Division and Dr. **Michael Bailey**, Associate Professor of Operations Research at NPS. The early goals of the project were to answer the reliability questions of the Mk 45 Gun System and ammunition. Later the goals became more general, improve gunnery. Over the last few years NPS has conducted shipboard briefings on Naval Gunfire Support (NGFS) procedures, GWS operation, spotting, and ammunition characteristics. NPS students and faculty created a number of simulations to provide analytical evaluation. A data collection effort at the live firing range Vieques, Puerto Rico, continues to provide information useful for training and analysis. Soon a data collection effort will start at San Clemente off southern California which will enable better standardization of operations among East Coast and West Coast ships and training facilities.

During Fleet Battle Experiment "B" NPS partnered with METRON in San Diego, the producer of the Navy Simulation System (NSS), to evaluate and provide the gun portion of the data for the experiment onboard USS CORONADO. The Institute for Joint Warfare Analysis (IJWA) at NPS and the Gunworks project continue to support the Fleet Battle Experiments. This year, ship rides have been conducted aboard USS CARON, USS COLE, USS LABOONE, USS SAN JACINTO, USS MONTEREY, and USS ROSS during Naval Gunfire Qualification and spotting exercises. The many ship visits conducted over the past seven years have been the genesis of system improvement initiatives. As an example of improvements, the automation of the estimated initial velocity (IV) calculation was initiated as

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The projectile is caught on film as the Arleigh Burke-class destroyer USS Benfold (DDG 65) fires its five-inch 54-caliber MK45 gun during routine training operations off the coast of southern California. The MK 45 provides surface combatants with accurate naval gunfire against fast, highly maneuverable surface targets, air threats and shore targets. U.S. Navy photo by Photographer's Mate 2nd Class Felix Garza Jr. [970416-N-4142G-002] April 16, 1997.

CENTERS

CENTER FOR SHORE INSTALLATION MANAGEMENT PROPOSED AT NPS

A Memorandum of Understanding between the Naval Postgraduate School and the Shore Installation Management (SIM) Division of the Office of the Chief of Naval Operations has been proposed to establish a Center for Shore Installation Management (C-SIM) at NPS. The overall objective for establishing C-SIM is to provide a direct relationship between the Director, Shore Installation Management (N46), and NPS in order to provide opportunities for the professional development of both faculty and students in the SIM Program at NPS, and to conduct research in areas of shore installation management. Specific research objectives will be to focus on topics of immediate concern to the Director, SIM, and perform research on future evaluations in installation management.

C-SIM is an outgrowth of the Installation Management Program developed by the Department of Systems Management at NPS to prepare officers for the managerial challenges associated with operating a military installation. The program is designed for military officers, i.e. executive officers, operations officers, supply officers, or public works officers, whose future duty assignments will require that they be skilled managers; be critical analysts of organizational systems, groups, and individuals; knowledgeable of the increasingly complex managerial environment associated with installations; and skilled communicators in the public environment. The program prepares officers to meet these responsibilities through graduate management education based on current and accepted theory and research, and taught by faculty who are knowledgeable of Department of Defense policy, structure, and effective practices.

CAPT Howard Norman Kay, USN, wrote an article for the *Proceedings*, published by the U.S. Naval Institute in December 1977, titled, "Managing the Shore Establishment." In the article he stated, "The presumption seems to be that the four-striper who has excelled during a command at sea is thereby capable of commanding one of the Navy's sprawling bases or stations. But the fact is that successful management of a diversified shore establishment bears little, if any, similarity to commanding a surface ship, submarine or air wing at sea."

GUNWORKS, *continued from page 14*

the result of discussions and observations during ship visits. Also on the newer class ships, the velocimeter was designed into the system so that the system IV estimate is statistically based on immediate past known data. Other issues precipitated in this fashion were utilization of GPS, fuze-setting issues resulting in the solution of a multipurpose fuze, long range accuracy, and the resolution of illumination failures or "dark stars."

In the performance of this project, NPS has initiated, fostered and maintained relationships with the Marine Corps Combat Development Center, the Naval War College, N81, N86, SURFLANT, SURFPAC, CNET, NSWC DAHLGREN, AFWTF Puerto Rico, EWTGLANT, and EWTGPAC.

The Gunworks Project developed eF, a simulation written in MODSIM, for its initial studies. Recent developments have used NSS, which is installed in the Secure Systems Technology Lab (SSTL). Currently in conjunction with Expeditionary Warfare Training Group Pacific (EWTGPAC), NPS is investigating improvements on the automated forward observer training system (FOTS). The FOTS system is installed on an NT server using voice recognition software to enable the reduction of instructor to student ratio significantly. Another benefit of FOTS is that each spotter trainee is able to get 8 to 12 times more hands on training than the previous puff board trainer. General Campaign Analysis Modeling System (GCAMS) is another set of tools that is being used for GWS modeling.

Future initiatives of Gunworks are to establish a gun system web page to provide a connection for the host of existing gun web pages and a single source of current information accessible for a ship to download regarding gun issues; construction of a toolbox of scenarios and performance evaluations to support ongoing analysis of future ammunition and gun weapons; and updating the accuracy and effectiveness of Naval Ammunition in the reference manuals.

The objectives of the project are several: improve gunnery in the Navy; promote joint training through the interaction of students and faculty with Navy operating units and other DoD units and agencies; and stimulate ideas and discussion about the employment of the GWS with emerging land attack technologies, littoral warfare, and network centric warfare.

Anyone interested in participating in the work or getting further information on this project should contact Alex Callahan at 408-656-2221, John Bowden at 408-656-2938 or Gordon Schacher at 408-656-1104.

VIRTUAL ENVIRONMENT RESEARCH "MOVES" NEW CURRICULUM

The Naval Postgraduate School's virtual environment (VE) research and education efforts were initiated by a group in the Department of Computer Science called the NPSNET Research Group. For the past decade, the NPSNET Research Group has focused on human-computer interaction and software technology for developing and implementing large-scale virtual environments (LSVEs). Their research has been applied to constructing VEs for DoD.

Virtual environments are being used more and more for training efforts. The environments are becoming more complex as the demand grows for this platform as a means of enacting real-world engagement scenarios. The "virtual world" is dependent upon the researchers of today—on groups such as the NPSNET Research Group. Many of today's researchers were educated in traditional programs such as computer science, electrical and computer engineering, or human factors. The question is, "Will these programs meet the virtual world's requirements for tomorrow?"

Several reports, including the National Research Council's, *Virtual Reality: Scientific and Technological Challenges*,[1] and the more recent, *Modeling and Simulation: Linking Entertainment and Defense*,[2] have discussed the need for programs that focus more closely on the issues of how the software and content for networked environments are developed. Both reports point out that the more effective VE developer will not be just a computer scientist, electrical engineer, or human factors specialist, but rather a scientist who sits between, whose education integrates the precise parts for developing a virtual environment.

The NPSNET Research Group has been instrumentally involved in the formation of a new degree program being offered at NPS to meet the VE needs for tomorrow. The Modeling, Virtual Environments, and Simulation Degree Program, MOVES, aims to provide students with a basic computer science background coupled with operations analysis and mathematics. This in itself is not enough to educate VE developers. Their education must also entail the study of human-computer interaction technology use and evaluation as applied to VEs. To meet these objectives, the MOVES curriculum offers two tracks: a visual simulation track that focuses on technology development for the VE and a human-computer interaction track that focuses on technology use and human performance evaluation for VEs.

The Navy has created a subspecialty that requires the MOVES degree and plans to send ten students per year. The U.S. Army has also created a subspecialty for modeling and simulation and will send five officers per year to the program.

A student works at the Wide Field-of-View Helicopter Navigation Trainer.

As with most graduate curricula at NPS, all MOVES students must successfully complete a thesis to graduate. Thesis topics are quite often selected from the sponsored projects of NPS faculty. Thesis topics available to the MOVES students and other Computer Science students working with the NPSNET Research Group include: the design of LSVE network software architectures, web-based interoperability, cross-platform VE toolkits, 3D VE construction, inertial motion tracking, locomotion devices, human modeling in the VE, uses of spatial sound, wayfinding in the VE, architectures for computer-generated VE characters, and DoD applications of VE technology.

CPT Stewart Liles, USA, is working with Professor **Michael Zyda**, Department

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MOVES, *continued from page 16*

of Computer Science and Director of the NPSNET Research Group, on a cross-platform VE toolkit called Bamboo. Bamboo, an extensible framework for building networked VEs that collects the core mechanisms common to networked environments, is being developed to meet the requirement for a low-cost, general-purpose, cross-platform, high-level toolkit that provides a well-designed framework facilitating VE application research and development.

Consistency in networked VEs is a major area of concern as models become more complex with an increasing number of entities and networks covering a wider geographic area. Most work in this area has concentrated on the consistency of each entity in a VE. CPT Liles and Professor Zyda are focussing instead on the models that simulate those entities. To show that consistency can be achieved without using client-server models that track each entity, the thesis research aims to ensure that each simulation host has the same algorithms to model each type of entity. Bamboo is being used to dynamically load and unload program modules during the runtime. Network communication is accomplished using the Defense Modeling and Simulations Office's High Level Architecture.

Several students are working on theses related to navigation in large-scale VEs. Working with Assistant Professor **Rudy Darken**, **CPT Simon Goerger**, USA, completed a study comparing performance on a sport orienteering task between individuals who were trained using only maps, a VE with the maps, or the real environment with the maps. Two experienced helicopter pilots, **LCDR Joe Sullivan**, USN, and **Capt Tim McClean**, USMC, investigated this same problem in terms of low-altitude air navigation. They are currently working with a helicopter squadron at the Naval Air Station North Island in San Diego, California, to construct and evaluate a training system to help student pilots learn to visualize terrain from contour maps.

An interesting spin-off of the navigation in large-scale VEs has been an investigation of techniques for constructing high-fidelity geometric models of real environments for Navy simulation and trainers. A significant amount of detail might be required in a VE to achieve the desired effect, whether a specific level of performance, transfer or graining, or simply an immersion into the simulated space. Captains McLean and Goerger and LCDR Sullivan, working with Professor Darken, are measuring the effects

Computer simulation of the inside of the LPD-17 with an amphibious vehicle

that drive the requirements of how detailed a model must be. They are investigating methods for constructing both manmade (building interiors) and natural environments.

A fundamental part of navigation is locomotion, or the mechanism used to get from here to there. A mechanism built for this purpose, the Omni-Directional Treadmill (ODT), was at NPS for integration with NPSNET-IV and provided the opportunity for **William Cockayne**, a DoD civilian, to conduct a study that uncovered a method for evaluating devices and techniques based on their adherence to human abilities.

LT Steve Norris, USN, is working with Professor Darken to develop a cognitive model of ship handling tasks for a larger project for the Surface Warfare Officer School (SWOS) at Newport, Rhode Island. A real-time simulation of an LPD-17 and amphibious vehicle constructed by a previous student, **LT Didier LeGoff**, USN, is being used along with other surface-ship simulators to model the task to develop a training system using simulations that address the primary training needs at the necessary fidelity level.

[1] Committee on Virtual Reality Research and Development, National Research Council, *Virtual Reality: Scientific and Technological Challenges*, N. Durlach and A. Mavor, eds., National Academy of Sciences Press, Washington, DC, 1995.
[2] *Modeling and Simulation: Linking Entertainment and Defense*, M. Zyda and J. Sheehan, eds., National Academy Press, Washington, DC, September 1997.

NPS OCEANOGRAPHERS AWARDED NOPP GRANTS

The National Oceanographic Partnership Program (NOPP) was initiated with the signing of the Fiscal year 1997 Defense Authorization by President Clinton. The primary objectives of NOPP are to promote the national goals of assuring national security, advancing economic development, protecting quality of life, and strengthening science education and communication through improved knowledge of the oceans. For FY98, approximately $10M is available for new NOPP research efforts. The National Ocean Research Council (NORLC), chaired by the Secretary of the Navy and the Administrator of the National Oceanographic and Atmospheric Administration (NOAA), grants final approval of proposals submitted to NOPP.

Seventy-two (72) proposals were submitted for FY98 NOPP consideration nationally with only 12 successful awards. NPS oceanographers are involved in two. Associate Professor **Jeffrey Paduan**, Department of Oceanography, in partnership with a team comprised of NPS, the Naval Research Laboratory, the University of Michigan, the California State University Monterey Bay, the University of Southern Mississippi, the Monterey Bay Aquarium Research Institute, HOBI Labs of Watsonville, California, and Codar Ocean Sensors, Ltd. of Palo Alto, California, was awarded a NOPP grant to develop, "An Innovative Coastal-Ocean Observing Network (ICON)." The project will build on the existing network of oceanographic instrumentation around Monterey Bay, including High Frequency radars, moored instruments, and the NPS Ocean Acoustics Observatory at Point Sur. To this data mix will be brought numerical modeling and ocean optics expertise.

Funding at the level of $2.4M over two years will allow the implementation of a coastal ocean forecast model that assimilates a unique complement of real-time data. Once in place, this "natural laboratory" built using resources and expertise from around Monterey Bay, will be useful to other ocean scientists modeling primary productivity, chemical dispersal, and fisheries ecology, as well as operational Naval commands seeking to test new-generation sensors and models developed for the littoral environment.

Scientific investigators at NPS involved with the project along with Professor Paduan include Research Associate Professor **Leslie Rosenfeld**, Research Professor **Steve Ramp**, Professor **Ching-Sang Chiu**, Professor **Curt Collins**, and Research Associate Professor **Newell Garfield**.

Professors Collins and Chiu are also participating in a successful NOPP proposal with partners from Scripps Institution of Oceanography, the Applied Physics Laboratory of the University of Washington, and NOAA's Pacific Marine Environmental Laboratory. This partnership proposal, "Ocean Acoustic Observatory Federation," was submitted through Scripps as lead and is funded at $4.2M for two years. The partnership aims to convert the disbanded Navy underwater acoustic surveillance systems in the North Pacific into marine research tools. The scientific studies planned include earthquake and volcano seismicity, marine mammal behavior, and eastern boundary ocean circulation, the latter being NPS' component in this ocean partnership.

Both successful NOPP proposals use and leverage on the existing capabilities and expertise of the NPS Ocean Acoustic Observatory (OAO) which operates a former SOSUS array for undersea research at Point Sur. The OAO, developed and maintained by the NPS Coastal Ocean Acoustic Center (COACt), owes it success to the students, technical staff and former NPS military instructor, **LCDR Josh Rovero**. Professor Ching-Sang Chiu is the director of COACt. (See story on COACt on page 13.)

MONTEREY BAY CRESCENT OCEAN RESEARCH CONSORTIUM (MBCORC)

Many institutions with responsibilities for graduate or professional education, research or operational programs related to air-ocean science, engineering, or policy rim Monterey Bay. A Memorandum of Understanding was signed on 20 May 1998 establishing the Monterey Bay Crescent Ocean Research Consortium (MBCORC). MBCORC was proposed and established in order to provide a framework and mechanism for cooperative and collaborative activities of mutual interest in education, research, and operational ocean-related activities. The name "Monterey Bay Crescent" captures the spatial and

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PROJECT NOTES

THE ABSOLUTE WEAPON REVISITED

Associate Professor James Wirtz
Department of National Security Affairs

A project launched in 1995 has culminated in an edited volume published by the University of Michigan. The volume, *The Absolute Weapon Revisited: Nuclear Arms and the Emerging International Order*, evaluates the role of nuclear weapons in international politics following the end of the Cold War. Wirtz, along with co-editors T.V. Paul of McGill University and Richard Harknett of the University of Cincinnati, assembled an international group of scholars to conduct this far reaching assessment which follows in the footsteps of Bernard Brodie's seminal work, *The Absolute Weapon* (1946). The volume explores traditional nuclear weapons issues: the relationship between nuclear deterrence and international stability; arms control; the optimal size of nuclear arsenals; and the perils and potential benefits of nuclear proliferation. The volume also addresses issues—nuclear terrorism and the relationship between nuclear weapons and the Revolution in Military Affairs—that are now emerging on the strategic horizon. This multi-year project represents a highly successful effort to combine scholarly and policy making agendas. The project also benefited not only from joint, but international sponsorship. The Navy International Program Office, the U.S. Air Force Institute of National Security Studies, the Canadian Departments of Foreign Affairs and National Defense, McGill University, the University of Montreal and the Charles Phelps Taft Memorial Fund all supported the project.

HIGH FREQUENCY (HF) RADARS FOR COASTAL OCEANOGRAPHY

Associate Professor Jeffrey Paduan
Department of Oceanography

A special volume of *Oceanography*, published 3-4 times a year by the Oceanography Society, was dedicated to the use of HF radars in coastal oceanography. The volume, sponsored by the Office of Naval Research and the U.S. Army Engineer Waterways Experiment Station, and co-edited by Jeff Paduan and Dr. Hans C. Graber of the University of Miami, introduces this new coastal ocean technology to a wide audience within the oceanographic community. The volume contains 16 articles describing the history, theory and successful uses of HF radar in oceanography. HF radar is a noninvasive measurement tool that can acquire vector surface current, wave, and wind information, and is capable of providing wide-area measurements that are difficult or impossible to make any other way.

HF radar measurements are of increasing interest to the Navy in its tactical decision making. Naval operations in the littoral zone encounter numerous challenges in mine countermeasures and during amphibious landings. Improved knowledge of the local sea state is crucial for the detection and defense of surface-skimming missiles. The Army's interest is twofold. Militarily, logistics over the shore (LOTS) are critical to disembarkation of equipment and the temporary maintenance of harbors. The Army's civilian interest is centered around the Corps of Engineers' responsibility for the health and maintenance of our shorelines.

ALPHA-CONTRACTING

Assistant Professor Mark Nissen
Department of Systems Management

An acquisition reform technique called "alpha contracting" extends the integrated product team (IPT) concept into the contracting process and can produce quantum improvement in terms of acquisition lead time, contracting cost and quality of contractual documentation. This project, sponsored by the Naval Air Warfare Center Weapons Division (PMA-201), focused specifically on the innovative alpha-contracting techniques employed on the Joint Stand Off Weapon (JSOW) Program.

Results from the field research project have been developed into an instructional case now used in graduate course work at NPS and being considered for instructional use elsewhere.

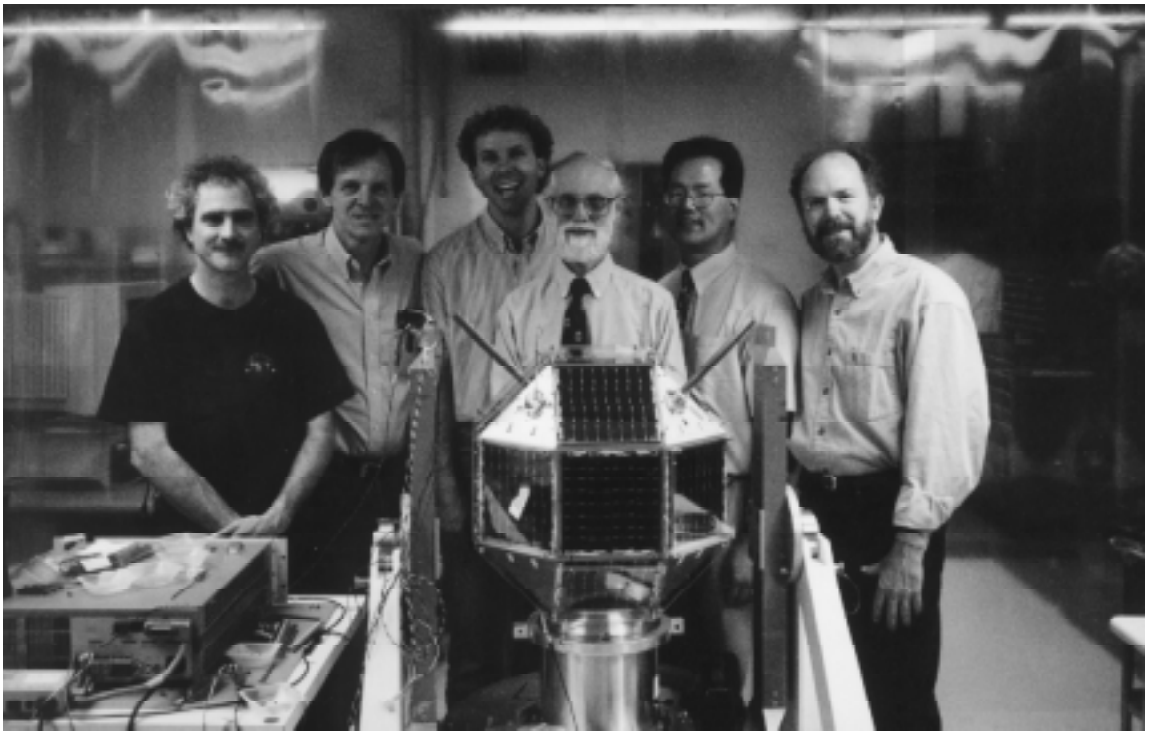
PANSAT HEADS FOR LAUNCH

Professor Rudy Panholzer, Principal Investigator and Project Manager, Dan Sakoda, Jim Horning, Ron Phelps and David Rigmaiden, Project Engineers, and Glenn Harrell, Model Maker,
Space Systems Academic Group

The Petite Amateur Navy Satellite (PANSAT) left NPS in early May bound for the NASA Goddard Space Flight Center (GSFC) and successfully underwent functional and environmental testing in preparation for integration with the International Extreme-ultraviolet Hitchhiker-3 (IEH-3) payload. The IEH-3 payload is a suite of six experiments that will fly aboard Discovery on the STS-95 Shuttle mission. The launch, scheduled for October 29, 1998, will place PANSAT in a Low Earth Orbit (LEO) with an altitude of 300 nautical miles (345 mi. or 555 km) and an inclination of at least 28.45 degrees.

The 125 pound spacecraft was designed, built, and tested at NPS by students, faculty, and staff. The project marries the research goals of a proof-of-concept communications system and the educational goals of training officers skilled in the highly interdisciplinary fields of space systems engineering and space systems operations. Numerous theses have been published to develop this system that will supply store-and-forward, direct-sequence, spread-spectrum communication employing a small satellite. The operating center frequency is at 436.5 MHz with a transmission rate of 9,842 bits per second, and spread to about 2.5 MHz of bandwidth. NPS and amateur radio ground stations will be able to utilize PANSAT for store-and-forward communications. The spacecraft will also be used at NPS for various communications and spacecraft laboratory classes.

Direct-sequence, spread-spectrum modulation is a technique that spreads a conventional narrow band signal by mixing it with a bit stream. The result is a dilution of the signal energy with respect to bandwidth. The spread-spectrum signal has the same energy per bit as the narrow band signal, but the power density at any one frequency is significantly lower. The signal can be spread to such a point that it is entirely below the noise level of a conventional receiver, making it difficult to detect or intercept. The spread spectrum receiver uses the same bit stream as a key for acquisition, tracking, and decoding of the spread signal. In the demodulation process, conventional (narrow band) signals are suppressed, making it resistant to interference and difficult to jam.



"PANSAT" with the SSAG crew before shipping (from left to right, David Rigmaiden, Glenn Harrell, Jim Horning, Rudy Panholzer, Dan Sakoda, and Ron Phelps).

The spacecraft is made up by the electrical power subsystem (EPS), digital control subsystem (DCS), the communications payload, and the mechanical structure. The spacecraft has nine megabytes of storage for telemetry data and user messages. Solar panels cover the spacecraft for energy conversion while two

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PANSAT, *continued from page 19*

nickel-cadmium batteries provide energy storage for operation while in eclipse.

Vice Admiral Lyle Bien, Deputy Commander-in-Chief and Chief of Staff of the US Space Command, checked out PANSAT's progress during a recent visit. Pictured with VADM Bien are (from left to right) Rudy Panholzer, Ron Phelps, "Griz" Baldwin and Dan Sakoda.

PANSAT has provided students with the opportunity to gain practical education in Space Systems Engineering and Operations by way of theses, class projects, and directed study courses. Topics included areas such as mission operations, astrodynamics, mechanical and electronic subsystem design, system integration, and environmental testing. Over fifty theses by the students listed below are part of PANSAT's legacy.

LT David Alldridge, USN
LT John Ashe, USN
Jens Bartschat (German Military Exchange Student)
LT Steve Bible, USN
LT Arnold Brown, USN
LT Thomas Calvert, USNR
LT Daniel Cuff, USNR
Nick Davinic (DoD Civ)
LT David Dawson, USN
LT Peter A. Eagle, USN
CAPT Daniel Ellrick, USMC
LT Michael P. Finnegan, USN
LT Traci Ford, USN
LT Thomas Fritz, USN
LT Brian Gannon, USN
Olaf Gericke (German Military Exchange Student)
LT Russel Gottfried, USN
LT Gregory Hand, USN
Michael Hengst (German Military Exchange Student)
LT James Hiser, USN
James A. Horning (DoD Civ)
LT Robert Housee, USNR
MAJ Stephen Huneke, USA
LT George Hunter, USA
1LT Ercument Karapinar, Turkish Army
LT Carl Lahti, USN
LT Gregory Lawrence, USN
LCDR David Leu, USN
LCDR Terrence Murray, USN
LT Troy Nichols, USN
LCDR Michael Noble, USN
LT Stephanie O'Neal, USN
LT Craig Oechsel, USN
LCDR Paul Overstreet, USN
LCDR Stephen Paluszek, USN
LCDR Sheila Patterson, USN
CPT Robert Payne, USA
LT Lanny Rasnick, USN
LCDR Markham Rich, USN
CAPT Robert Rowsey, USMC
Daniel Sakoda (DoD Civ)
LT Fred Severson, USN
LT Irma Sityar, USN
LCDR Gary Smilowitz, USN
LT Travis Smith, USN
LT Jeffrey Stewart, USN
Frank Strewinsky (German Military Exchange Student)
LT Steve Tackett, USN
CPT Stephen Tobin, USA
LT Eric Victor, USN
LT David Weiding, USN

TECHNOLOGY AND THE MINE PROBLEM

The Third Symposium on Technology and the Mine Problem was held 5-9 April 1998 at the Naval Postgraduate School. Six government sponsors and nineteen corporate sponsors/exhibitors made the event possible. About 400 people were in attendance including representatives from Australia, Belgium, Cambodia, Canada, Croatia, England, France, Germany, Israel, Italy, the Netherlands, and Singapore.

LT GEN James Jones, Senior Military Assistant to the Secretary of Defense, addressed the Wednesday evening banquet about the efforts in the Office of the Secretary of Defense to fully support mine warfare. These efforts are more fully described in letters written by the Secretary of Defense to the Secretary of the Navy.

Fred Saalfeld, Deputy Chief of Naval Research, spoke of how we must transition from the needs of the war fighter today through the new systems we acquire tomorrow to make full use of science and technological developments for the military after next. As noted elsewhere by Larry Lynn of the Defense Advanced Research Projects Agency (DARPA), "the mine problem is critical and needs new technologies and techniques."

MGEN Edward Hanlon, USMC, Director, Expeditionary Warfare, Office of the Chief of Naval Operations, spoke of N85's areas of responsibility and the potential impact of technology. He reminded the audience of the high cost (many M$) of the damage that a few thousand dollar sea mine has caused in recent conflicts. What if an aircraft carrier were hit by a mine? He also noted the dramatic difference between the MH-53 and the H-60: the fuel for the one weighs as much as the other. Thus, for organic mine countermeasures (MCM) to become a reality, a dramatic shrinkage of sensors and equipment may be needed.

LT GEN John Rhodes, USMC, Commanding General of the Marine Corps Combat Development Center, gave an outstanding presentation focusing on the need to elevate MCM and spend sufficient funds on an annual basis to acquire the right systems. He noted that mines are in fact a show-stopper, not a speed bump, and we need to dedicate more than a lot of talk to solve the problem.

A recent GAO report was quoted from, which reinforced the need for deployed systems. LT GEN Rhodes noted that we need our hearts, minds, and dollars committed to MCM. He went on to comment that we needed to better focus on mine warfare in exercises—if we don't play it for real for once (and regularly), then we will never understand the impact of mines in a real conflict.

MG John Caldwell, USA, Assistant Chief of Staff RD&A, U.S. Army Materiel Command, discussed the Joint Countermine Advanced Concept Demonstration—the value added and the potential payoffs. The systems which participated in Demo I were mentioned--ORSMC (Off-Route Smart Mine Clearance-Army), CIMMD (Close-In Man-portable Mine Detector-Army), ASTAMIDS (Airborne Standoff Minefield Detection System-Army), COBRA (Coastal Battlefield Reconnaissance and Analysis-USMC), PB Power Blade (Congressionally directed), JAMC (Joint Amphibious Mine Countermeasures-Marine Corps), ENATD (Explosive Neutralization Advanced Technology Demonstration-Navy), MLA (Magic Lantern Adaptation-Navy), LRS (Littoral Remote Sensing-Navy)--as well as specific system payoffs in C4I, airborne reconnaissance, and simulation. Demo II will take place 6-19 June 1998 as part of a NATO Naval exercise.

MG Roy Beauchamp, USA, Commanding General of the Tank-Automotive and Armaments Command, focused on countermine challenges and the need for a seamless sea to land countermine process. He noted, "the solution is within our reach, but not within our grasp." The Joint UXO Center of Excellence was explained with its focus on countermine, humanitarian demining, EOD, range clearance, and environmental remediation. MG Beauchamp noted that there are 750 mine types worldwide with 2500 mine and fuse combinations.

RADM Paul Tobin, Oceanographer of the Navy, noted that the top four priorities of the Navy include mine warfare! RADM Burnham McCaffree, USN (Ret.) commented that the USN currently has only 5000 moored and 11,500 bottom mines in the inventory!

MG Joseph Garrett, USA, spoke about the U.S. Demining 2010 initiative. The idea is to accelerate international efforts to end or reduce casualties from land mines by 2010.

MAJ Colin King, British Army (ret.) spoke of the many international efforts in humanitarian demining that should be devoted to returning land to the civilian population and reducing or eliminating casualties from land mines and UXO. He noted that although many still don't understand the fundamental problems of demining, the S&T world and the deminers are beginning to work together. The main

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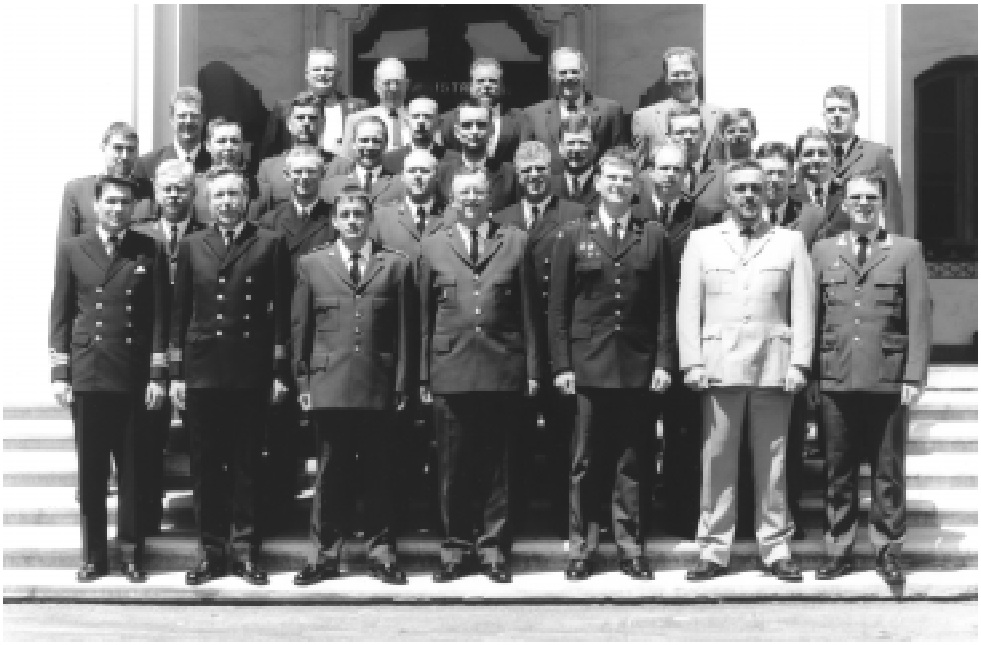
SHORT COURSES

SHORT COURSE OFFERED TO SWEDES

The Naval Postgraduate School's Center for Joint Services Electronic Warfare conducted a three-week workshop to officers from the Swedish National Defence College on "Warfare Technology for 2010." Organized by Associate Professor **Phillip Pace** of the Department of Electrical and Computer Engineering, the course was well received by the 25 officers attending. Sessions presented by NPS faculty during the course included Tactical Operations, Operational Analysis of Weapons Systems, Unmanned Aerial Vehicles, Weapons Effects, Advanced Signal Conversion Techniques for Reconnaissance and Electronic Warfare Receivers, Low Observables and Microwave Weapons, War Gaming, Systems Engineering, Ship Self Defense and Missile Technology, Sensor Fusion Technology, Advanced C2 Communications, and new technologies in Asynchronous Transfer Mode. The course also included field trips to the Electromagnetic Systems Division of TRW and Condor in the Silicon Valley. LTC Effe Ostman, Course Director in Military Technology from the Swedish National Defence College, stated, "...the quality of teaching and research at this university [NPS] is second to none. It is the best technical university in the world!" The success of the three-week course has made it an integral part of the 2-year curriculum at the Swedish National Defence College, and opened discussion about other collaborative efforts including professor exchanges, joint research projects, and additional students for NPS' degree granting programs. The next course is scheduled for early next year.

TECHNOLOGY REVIEW AND UPDATE

The 1998 Technology Review and Update for Technical Personnel Short Course was attended by over 80 representatives from government and industry. The five-day course, organized by Professor **Rudolf Panholzer**, Dean of Science and Engineering and Chair of the Space Systems Academic Group, covered several areas of interest to DoD and also provided participants with a tour of selected NPS research labs. **Vicente Garcia**, Cryptologic Chair at NPS, opened the week with an overview of Cryptology, Present and Future. **LCDR Steve Iatrou**, an instructor in the Information Warfare Academic Group, followed with a presentation on Information Warfare. Micro Electro-Mechanical Systems were explained by Professor Richard M. White of UC-Berkeley. James Lenz of Honeywell, Inc., covered Optical Sensing Technology. Computers and Networks were discussed by NPS Computer Science faculty, Professors **Debra Hensgen**, **Taylor Kidd**, **Geoffrey Xie**, and **Cynthia Irvine**. Dr. James Stuart, a private consultant, spoke on Satellite Communications and Trends. Peter Alfke, Director of Application Engineering, Xilinx, Inc., addressed Integrated Circuits. The week ended with Dr. Hamid Berenji, President and CEO of Intelligent Inference Systems Corporation, on the topic of Computer Intelligence. Feedback from participants was excellent and future courses will continue to respond to the changes rapidly occurring in technology today.



Students from the National Defense College with their NPS instructors following the "Warfare Technology for 2010" short course conducted at the School.

AIRCRAFT COMBAT SURVIVABILITY SHORT COURSE

Distinguished Professor **Robert E. Ball** of the Department of Aeronautics and Astronautics organized and taught a week long short course titled, "Aircraft Combat Survivability," 27 April-1 May 1998. The short course was first presented at NAVAIR in 1978 and at NPS in 1979. Since then, Dr. Ball has taught the course 14 times at NPS, NAVAIR and NAWC-Weapons Division with over 1300 students attending.

The 95 attendees included representatives from the military services and industry, as well as DoD civilians. The first four days contained the essential ingredients for the study of the combat survivability of fixed-wing aircraft, rotary-wing aircraft, and guided missiles in a man-made, nonnuclear hostile environment. Major topics presented included: an introduction to the fundamentals of the discipline; the Tri-Service survivability organizations and the survivability programs for several aircraft; the Live Fire and Joint Live Fire Test programs; the threats and their effects; combat data; an overview of the assessment methodology; aircraft signatures; threat system detection and tracking capabilities; electronic warfare; vulnerability and susceptibility; electronic warfare; vulnerability and susceptibility reduction and aircraft battle damage repair. Along with Professor Ball, other experts who taught these topics were: Mr. James O'Bryon, Office of the Secretary of Defense; Mr. Leo Budd, Mr. Hardy Tyson, and Mr. Charles E. Frankenberger, III, NAWC-Weapons Division; Mr. Martin L. Lentz and Mr. Donald W. Voyls, Air Force Research Lab: Mr. Kevin Crosthwaite, SURVIAC Director; Mr. Hugh Griffis, USAF Aeronautical Systems Center; Mr. Raymond R. Flores, JTCG/AS Central Office; Lt Col Phil Meteer, Air Force Mission Planning Systems, USAF Electronic Systems Center; Mr. Larry D. Johnston, SFAE-AV-AEC; Mr. Ken Goff, CDR David Dunaway, and Mr. Carl Wolf, NAWC-Aircraft Division; CAPT Dale Milton, NAVAIR; and Mr. Gene A. Birrocco, USA Aviation and Troop Command.

The fifth day was devoted to a detailed presentation of the methodology and the computer programs currently used for vulnerability, susceptibility, and survivability assessment. These presentations were given by Mr. David Hall, Chief Analyst, Survivability and Lethality Division, NAWC-Weapons Division, and Chair of the JTCG/AS Survivability Methodology Subgroup.

Distinguished Professor Robert E. Ball (left) with participants attending the Aircraft Combat Survivability Short Course held at the Naval Postgraduate School in May.

CHAIR PROFESSORSHIP IN PUBLIC MANAGEMENT ESTABLISHED

A Memorandum of Understanding was recently entered into with the Space and Naval Warfare Systems Command to establish the Admiral George F. A. Wagner Chair in Public Management. The objective in establishing the Chair Professorship is to further develop and enhance the relationship between NPS and SPAWAR in the areas of public management. The Chair will provide research, analytical and other services devoted to resolving public management issues, including financial management issues, of importance to SPAWAR, the Navy, DoD, and the public management community.

The first chair incumbent, **Lawrence R. Jones**, will assume his duties on 1 October 1998. A tenured professor in the Department of Systems Management, Professor Jones teaches and conducts research on public financial management and public management issues. His undergraduate degree in political science was earned from Stanford University, followed by a master of arts in public policy and Ph.D. in public budgeting and finance from the University of California, Berkeley. Professor Jones is the author or co-author of more than seventy journal articles on topics including management and budget control, public financial management, government retrenchment and regulatory policy. He has published seven books, the most recent in 1997 titled, *International Perspectives on the New Public Management*. In 1995, he and co-author Fred Thomas received an award for best defense publication of the year from the American Society for Military Comptrollers for their book, *Reinventing the Pentagon*. Professor Jones' research has been supported by the Comptroller of the Navy, Commander, Naval Air Pacific Command, the Naval Sea Systems Command, and the Office of the Comptroller, Secretary of Defense.

The Chair honors the career accomplishments of RADM George F. A. Wagner who served as the Commander of the Space and Naval Warfare Command from 1995 until his recent retirement in April. As COMSPAWARSYSCOM, RADM Wagner directed the development, acquisition and life cycle management of command, control, communications, computers, intelligence surveillance and reconnaissance (C4ISR) systems for the United States Navy and United States Marine Corps, and selected joint service programs. Prior to assuming command of SPAWAR, RADM Wagner served as the Program Executive Officer of the Cruise Missile Projects and Unmanned Aerial Vehicles Joint Program; Director of Force Engineering at SPAWAR; Director of Material Professional Personnel Policy for the Deputy Chief of Naval Personnel (Manpower, Personnel and Training); Deputy Chief of Naval Research; Program Manager of the TOMAHAWK Cruise Missile Program, Assistant Technical Director of the Computer Aided Ship Design and Construction Projects at the Naval Ship Engineering Center; Assistant for Fleet Introduction on the staff of the Deputy Commander for Surface Combatant Ships, Naval Sea Systems Command; and as an instructor at the Senior Officer Ship Material Readiness Course. Sea assignments included command of the USS JOHN RODGERS (DD983), First Executive Officer of the USS SPRUANCE (DD 963), Engineer Officer on the USS BELKNAP (CG26), Commander, Cruiser Destroyer Force, U.S. Atlantic Fleet, and Operations Officer and Damage Control Assistant on the USS RADFORD (DD446). In 1997, RADM Wagner assumed the honorary title of the Navy's "Old Salt" as the most senior Surface Warfare Officer on continuous duty.

Professor Lawrence Jones (standing) was awarded the Aaron Wildavsky Book Award this year from the Policy Studies Organization for authoring one of the best books in the field of public policy and management in the past 20 years. The award was given for the book, *Mission Financing to Realign National Defense* (Greenwich, CT: JAI Press, 1992), which was coauthored with LtCol Glenn C. Bixler, USMC, when Bixler was a student at NPS. The book is currently used as a text at NPS and other universities.

SPAWAR SYSTEMS CENTER-SAN DIEGO STUDENT FELLOWSHIPS AWARDED

Four NPS students were awarded Student Fellowship Awards by the Space and Naval Warfare Systems Centers-San Diego (SSC-SD). The Fellowship provides a $10,000 stipend for the student to assist in their thesis research and to provide travel for two on-site visits to SSC-SD.

LT Cynthia M. Fulmer, USN, will be working with **Vicente Garcia**, Cryptology Chair at NPS, and LT Melody Kragh, SSC-SD Communication and Information Systems Department, and Mr Robert Matthews, SSC-SD Intelligence Office. The ultimate goal of LT Fulmer's research is to present the Fleet with critical information on Wireless Local Area Networks (WLANs). The main issue of WLANs is its vulnerability. Her research will focus on connectivity, security and integration. A WLAN will be built at NPS and placed in the Computer Network Attack Laboratory providing students with an instructional tool for understanding WLANs and their security issues.

Lt Col John Gibson, USAF, working with Vicente Garcia and Mike Harrison, of the SSC-SD Communication and Information Systems Department, will provide an assessment of selected potential areas of vulnerability resulting from the current trend in the commercial sector to integrated voice, data, and video networks and the corresponding trend in the DoD under the C4I for the Warrior vision. Specific areas to be addressed include the impact on signals intelligence capabilities of integrating multiple media products over a single network, the maturation and fielding of the Asynchronous Transfer Method (ATM) protocol, and the need to develop collection techniques and procedures, due to this protocol migration, to assure critical decision makers are provided with timely information. The goal of this effort is to establish an ATM simulation in the Computer Network Attack Laboratory.

Capt Darin Powers, USMC, will be working with Professor **Dan Boger**, Dean of Computer Information Sciences and Operations, and Dr. Roy Axford of the SSC-SD Communications and Information Systems Department, on a template to evaluate wideband satellite communication systems for Naval applications. Given the dispersed nature of the future battlefield, it is clearly evident that an integrated and robust communication architecture that meets the goals set forth in 21st century vision documents, such as Joint Vision 2010 and the Navy's Operational Maneuver from the Sea, will rely on space-based communications (SATCOM). Furthermore, wideband SATCOM assets will be critical contributors to any DoD

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NSAP FUNDS STUDENT THESIS RESEARCH

The Office of Naval Research's Navy Science Assistance Program (NSAP) supports areas of research specifically aimed at real-time problems of the operational Navy. Two students were recently awarded NSAP funding to support their thesis research.

LCDR James R. Townsend, USN, will be working on a problem identified by the Commander, Submarine Force Pacific (COMSUBPAC). The drawdown of submarine forces continues to restrict the ability of COMSUBPAC to meet the competing goals of forward presence, battle group support, required maintenance, and quality of life for submarine crews. Efficient scheduling of all operations and maintenance periods is necessary to ensure that critical missions are supported while fulfilling as many lower priority requirements as possible. A long-range (>1 month) optimization based decision support tool should be developed that will be useful to COMSUBPAC today, and can be extended or modified as necessary for tomorrow.

LCDR Townsend's thesis will express COMSUBPAC's problem as a mixed integer-programming model that can be defined and prototypically implemented in GAMS algebraic modeling system. The program should be capable of interacting with other scheduling systems such as VIPER, developed by SAIC and currently undergoing acceptance testing.

The design, construction and demonstration of a prototype nonlethal weapon is the goal for **Maj Franz Gayl**, USMC. The military, especially the U.S. Marine Corps, is engaged in Military Operations Other than War (MOOTW). In these situations, nonlethal weapons (NLW) capability is essential to complete missions with a minimum potential for casualties. The prototype acoustic weapon proposed by Maj Gayl will attempt to overcome known acoustic weapons limitations by combining a completely integrated combined arms NLW design which includes a light source of weapons intensity with the combined NLW being modularly adaptable to an operator's firearm. The purpose of such a design is to enable the operator to rapidly transition between levels of weapons effects.

FREQUENCY DEPENDENCE OF SINGLE EVENT UPSETS IN GALLIUM ARSENIDE METAL SEMICONDUCTOR FIELD EFFECT TRANSISTORS

Maj James E. Devers, USMC
Advisor: Assistant Professor Todd Weatherford
Department of Electrical and Computer Engineering

Single event upsets (SEUs) are the result of radiation particles passing through transistors in integrated circuits, introducing errors in logic and memory circuits. Gallium Arsenide (GaAs) Metal Semiconductor Field Effect Transistors (MESFETS) are desirable for future space systems due to their higher speeds of operation; however, they are also more prone to errors from single event upsets. In addition, it has been noted that the rate at which errors occur increases more than linearly with the operating frequency of the devices.

The goal of this research was to explore the temporal aspects of SEUs in GaAs MESFETs to determine the causes of vibration in upset rates with frequency. By performing two-dimensional simulations of inverter circuits, the fundamental building blocks of digital logic circuits, a more accurate simulation of SEUs was possible, providing greater insight into the mechanisms involved with SEUs in MESFET devices.

This thesis develops doping profiles necessary to match current device characteristics for both conventional devices and radiation tolerant devices with Low Temperature grown GaAs (LT GaAs). Techniques were developed to incorporate multiple devices in 2-D simulations to more accurately replicate circuit responses. Finally, it was shown that, as the operating frequency of the circuit increases, the susceptibility to upset increases at an even faster rate.

(Maj Devers presented results from his thesis at NRL and UC Berkeley. Harry Dietrich, Head, Microwave Devices and Material Section, Electronics S&T Division, NRL, expressed his appreciation for the work Maj Devers has done on the digital GaAs Single Event Upset Suppression Program in a letter to Maj Devers' advisor. Mr. Dietrich went on to say, "In the face of what I would have considered insurmountable obstacles, Major Devers has not only progressed but has imposed order onto chaos and in so doing made a major contribution to the program....His contributions have been very useful and quite impressive." Eicke R. Weber, Professor of Material Sciences at UC Berkeley, also wrote to say that, "The level of his [Maj Devers] understanding of point defects in GaAs is really impressive. The results of his model simulations have a direct impact into the design of future device structures...").

COST-BENEFIT ANALYSIS TO COMPARE A NEW HELICOPTER TRAINING PARADIGM TO THE STATUS QUO

LT Terry Hoeft, USN
Advisor: LCDR Tim Anderson
Lecturer of Operations Research

This thesis work entails developing a cost-benefit analysis for COMNAVAIRPAC to compare a new helicopter training paradigm to the status quo. The status quo training program calls for student Naval aviators training as helicopter pilots to complete primary and advanced training in the TH-57B/C. Following designation as Naval aviators, pilots are ordered to a Fleet Replacement Squadron (FRS) to undergo training in a Fleet aircraft. While training students in the TD-57 has been an efficient process in the past, since the reduction in Navy helicopters to a single model, the H-60, it may be prudent to change the way training is done.

The new paradigm calls for combining advanced undergraduate helicopter training with FRS familiarization training—eliminating an entire level of flight training. Pilots would report to an FRS following completion of Primary Helicopter Flight Training. Familiarization training for all H-60 Type/Model/Series would be conducted at the FRS utilizing the CH-60. Upon completion of the FRS, student pilots would have about 50 hours in model, an H-60 PQM qualification and would be designated as Naval aviators.

The objective of this study is to determine whether a change in the training paradigm will generate savings.

MINE CONFERENCE, *continued from page 22*

goal should be a "safer, faster, and more capable process or system."

Outstanding technical presentations and technical sessions covered environmental support, emerging technologies, autonomous systems, C4ISR, modeling and simulation, humanitarian demining, operational results, mine technology, UXO, organic Naval MCM, international mine warfare, and lessons learned.

ECE PROFESSOR SELECTED AS CHAIR OF N913 ASCM SIMULATOR VALIDATION WORKING GROUP

Anti-ship cruise missiles (ASCMs) are a significant threat to U.S. Navy surface ships. OPNAV 91 directs the Effectiveness of Navy Electronic Warfare Systems (ENEWS) Program to develop ASCM hardware in the loop simulators to support the research, development, test and evaluation of the most critical threats. The HIL missile simulators utilize captured or production representative missile hardware (seeker, guidance sections and telemetry) interfaced with high-performance computer modeling. The simulators are primarily used for test and evaluation of shipboard electronic warfare systems. They are also utilized in the acceptance testing of shipboard self-protection equipment and provide a major vehicle for evaluating the effectiveness of electronic attack.

To insure that the ASCM simulators (both IR and RF) accurately represent the threat missile, OPNAV 91 has established the Navy's unique ASCM Simulator Validation Working Group (SVWG). Associate Professor **Phillip Pace** of the Department of Electrical and Computer Engineering has been appointed Chair of the N91 SVWG to coordinate the validation process. The ASCM validation process includes processing the ASCM simulator through a battery of anechoic chamber tests in order to determine the simulator's performance relative to the actual threat weapons system. The tests are run and the results are collected in the Naval Research Laboratory's Tactical Electronic Warfare Division's Central Target Simulation facility. The results are used to determine how well the ASCM simulator performs compared to the actual threat. For example, the validation process guarantees that an Exocet simulator performs like an actual Exocet. This insures that the shipboard self protection systems can effectively counter the incoming ASCM to force the missile to miss the ship.

COMPUTER SCIENTIST AWARDED PATENT

Professor **Yutaka Kanayama** of the Department of Computer Science was recently awarded a patent for his invention titled, "A Method of Controlling a Vehicle to Make a Combination of Arbitrary Translational and Rotational Motions" (U.S. Patent Number 5,719,762).

RESEARCH RECOGNITION EVENING

NPS honored the Menneken Research Award recipient, Dr. **Indranath Dutta**, and recognized faculty for outstanding research achievements in 1997 at the Research Recognition Evening on 14 April. Pictured with **RADM Robert C. Chaplin**, Superintendent, and Distinguished Professor **David Netzer**, Associate Provost and Dean of Research, are the recipients present that evening. From left to right (first row): Associate Professor Indranath Dutta (Menneken Research Award recipient), Assistant Professor **I. Michael Ross** (Space Systems Academic Group), Professor **Robert Bourke** (Undersea Warfare Academic Group), Distinguished Professor **David Schrady** (Institute of Joint

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FACULTY NEWS

AERONAUTICS AND ASTRONAUTICS

Prof. **S.K. Hebbar** was recognized in Marquis *Who's Who in Science & Engineering, 1998*.

K.E. Jensen, **F. Fahroo,** and **I.M. Ross,** "Application of Periodic Optimal Control Theory to the Orbit Reboost Problem," 8th AAS/AIAA Space Flight Mechanics Meeting, Monterey, CA, 9-11 February 1998.

S.-Y. Park and **I.M. Ross,** "Gravitational Effects of Earth in Optimizing Delta-V for Deflecting Earth-Crossing Asteroids," 8th AAS/AIAA Space Flight Mechanics Meeting, Monterey, CA, AAS Paper No. 98-186, 9-11 February 1998.

M.D. Reyes, S.E. Matousek, and **I.M. Ross,** "Launch Period Analysis for the Jupiter Gravity Assist Opportunities to Pluto," 8th AAS/AIAA Space Flight Mechanics Meeting, Monterey, CA, 9-11 February 1998.

Prof. **I.M. Ross** was re-appointed (for a second term) as the Book Review Editor for the *Journal of Guidance, Control and Dynamics*.

Prof. **I.M. Ross** chaired the session on Comet and Asteroid Missions at the 8th AAS/AIAA Space Flight Mechanics Meeting.

W. Sanz and **M.F. Platzer,** "On the Navier-Stokes Calculation of Separation Bubbles with a New Transition Model," *ASME Journal of Turbomachinery*, Vol. 120, pp. 36-42, January 1998.

Prof. **R. Shreeve** is spending this quarter of his sabbatical with the Hypersonics Group at the University of Queensland in Brisbane, Australia. He will go to Stockholm, Sweden, to give two papers at the ASME International Gas Turbine and Aeroengine Conference and Exhibit before returning to NPS in June. The papers are entitled, "Sweep in a Transonic Fan Rotor: Part 1. 3D Geometry Package," by H.F.Abdelhamid and **R.P. Shreeve,** and "Sweep in a Transonic Fan Rotor: Part 2. CFD and Stress Analyses by H.F. Abdelhamid, **R.P. Shreeve** and **G.V. Hobson.** The papers resulted from Maj. Hazem Abdelhamid's Ph.D. thesis research.

I.H. Tuncer, M.F. Platzer, and R.D. van Dyken, "Navier-Stokes Analysis of Subsonic Flowfields over a Missile Configuration," *Journal of Spacecraft & Rockets*, Vol. 35, No. 2, pp. 127-131, March-April 1998.

I.H. Tuncer, M.F. Platzer, and R.D. van Dyken, "Computational Investigations of Subsonic High Angle of Attack Missile Flows," Paper No. 28, NATO-RTO Symposium on Missile Aerodynamics, Sorrento, Italy, 11-15 May 1998.

COMPUTER SCIENCE

H. El-Rewini and **T. Lewis,** *Distributed & Parallel Computing*, Prentice Hall, p. 447, March 1998.

C. Irvine was chair of the second Workshop on Education in Computer Security, Pacific Grove, CA, 19-21 January 1998.

C. Irvine, "Exploitation of a Covert Channel," Workshop on Education in Computer Security, Pacific Grove, CA, 19-21 January 1998.

C. Irvine was on the program committee of and chaired a session on access control at the IEEE Symposium on Security and Privacy, Oakland, CA, 4-6 May 1998.

Prof. **T. Lewis** received the "Certificate for Appreciation" from the IEEE Computer Society for serving as Editor-in-Chief of IEEE Computer magazine for two years.

Prof. **T. Lewis** completed a study for Defense Technical Information Center, Ft. Belvoir, titled, "Ahead of the Curve: An Architecture for DTIC into the Next Millennium," describing how DTIC can organize their computer systems and services to fit the demands of the next 10 years.

Luqi, V. Berzins, and **M. Shing,** "The Pacific Rim Software Process Engineering Research," *Proceedings of International Conference of Software Engineering*, Panel of Software Process, Japan, April 1998.

Luqi, V. Berzins, and **M. Shing,** "Autonomous Agents Design for Digital Network Maximization in Joint C4I System," *Proceedings of Modeling and Simulation of Microsystems, Semiconductors, Sensors and Actuators Conference*, Santa Clara, CA, 6-8 April 1998.

N.C. Rowe and **B. Frew,** "Automatic Caption Localization for Photographs on World Wide Web Pages," *Information Processing and Management*, 34, 1, 95-107, 1998.

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ELECTRICAL AND COMPUTER ENGINEERING

J.B. Knorr, "Shipboard HFDF System Simulation," *Applied Computational Electromagnetics Society Journal,* pp. 25-42, March 1998.

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R.J. Pieper, "Observations on Convergence Problems of Pipeline Networks," *Thirtieth South Eastern Symposium on System Theory*, pp. 39-42, March 1998.

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H.K. Bhargava and C.G. Tettelbach, "A Web-Based Decision Support System for Waste Disposal and Recycling," *Computers, Environment, and Urban Systems*, Vol 21, No. 1, pp. 47-65

A.P. Nikora, **N.F. Schneidewind,** and J.C. Munson**,** "IV & V Issues in Achieving High Reliability and Safety in Critical Control Software, Final Report, Volume 1 - Measuring and Evaluating the Software Maintenance Process and Metrics-Based Software Quality Control, Volume 2 - Measuring Defect Insertion Rates and Risk of Exposure to Residual Defects in Evolving Software Systems, and Volume 3 - Appendices," Jet Propulsion Laboratory, National Aeronautics and Space Administration, Pasadena, CA, 19 January 1998.

M. Nissen, "The TOPGUN Approach to Software Acquisition Education," *Crosstalk: the Journal of Defense Software Engineering*, Special Issue on Software Education and Training, 11:3, March 1998.

N.F. Schneidewind, "Integration of Software Reliability Predictions, Risk Analysis, and Testing Strategies," *Proceedings of the Tenth Annual Software Technology Conference*, (CD/ROM), Salt Lake City, UT, 20 April 1998.

N.F. Schneidewind, Tutorial: "Measuring and Evaluating the Development Process Using Reliability and Test Metrics," *Proceedings of the Tenth Annual Software Technology Conference*, (CD/ROM), Salt Lake City, UT, 21 April 1998.

Prof. **N. Schneidewind** has been named to the IEEE Computer Society Fellows Evaluation Committee. This committee evaluates and ranks candidates for election to the Grade of IEEE Fellow.

Prof. **N. Schneidewind,** at the invitation of the National Science Foundation, served on the Software Engineering and Languages Panel to review research proposals in this area.

N.F. Schneidewind, "Measuring and Evaluating the Stability of Maintenance Processes," *Proceedings of the Twenty-Second Annual Software Engineering Workshop*, NASA Goddard, Greenbelt, MD, 3-4 December 1997.

N.F. Schneidewind, "An Integrated Model for Software Reliability and Maintainability in a Distributed System," Computer Science and Operations Research: Recent Advances in the Interface, Monterey, CA, 9 January 1998.

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J. Arquilla and D. Ronfeldt, "Conceptual and Organizational Dimensions of Information-Age Conflict," *Information, Communication, and Society* (Winter 1998).

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Professor **Beny Neta** was elected to membership on the AIAA Astrodynamics Technical Committee.

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A. Fox and **E.S.K. Menon,** "Structure Factors and Bonding in NiAl," *Journal of Phase Equilbria*, 509, 1997.

A. Fox and **E.S.K. Menon,** "Debye-Waller Factors of Stoichiometric and A1- rich-TiA1 Alloys," *Philosophical Magazine* A, 577.

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M.T. Perez-Prado, **T.R. McNelley,** and M.E. McMahon, "A Model for Texture-Related Grain Boundary Misorientations in a Superplastic Aluminum Alloy," *Modeling the Mechanical Response of Structural Materials*, (E.M. Taleff and R.K. Mahidhara, eds.) TMS, Warrendale, PA, pp. 181-190, 1998.

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T. Sarpkaya, "Spray Generation and Drop Formation on Bow Sheets," Annual Meeting of ONR, CalTech, Pasadena, CA, 26-28 February 1998.

T. Sarpkaya, "Turbulent Vortex Breakdown at High-Speed Swirling Flows," National Science Foundation, Washington, DC, March 1998.

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A.L. Gordon and **J.L. McClean** "Thermohaline Stratification of the Indonesian Seas-Model and Observations," *Journal of Physical Oceanography*, in press.

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J. Luscombe, "Variational Tight-Binding Theory of Electrons in Compositionally Modified Semiconductor Superlattices," Meeting of the American Physical Society, Los Angeles, CA, 16-20 March 1998.

SYSTEMS MANAGEMENT

R. Barrios-Choplin, "The Effect of Communication Satisfaction on Employee Turnover," Annual Meeting of the Association for Business Communication, Washington, D.C., November 1997.

G. Fann-Thomas, "Research Think Tank: Complexifying International Communications and Communication Technology," *Business Communication Quarterly*, Vol. 60, No. 4, pp. 105-111, 1998.

B. Frew and **L.R. Jones,** "Information Era Influences on the New Public Management," *International Perspectives on the New Public Management*, **L.R. Jones,** K. Schedler, and S.W. Wade, editors, JAI Press, pp. 369-381, 1997.

K. Gue received funding from the Naval Facilities Engineering Services Center (NFESC) to assist in development of a Maintenance Deployment Commodity Planning Tool for the Marine Corps. The tool is a decision support program that will help deploying Marine units decide how much of which items to take on an operation. NFESC is interested in establishing a lab at NPS to work on a number of logistics-and information-related projects.

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J. Felli and **G. Hazen,** "Sensitivity Analysis and the Expected Value of Perfect Information," *Medical Decision Making*, Vol. 18, No. 1, January - March 1998.

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SIGNAL ENHANCEMENT LAB, *continued from page 3*

been developed that will allow the complete EM characterization of a military platform before weapons and EW systems are appended to the platform, for frequencies below radar bands. The act of adding an antenna to a structure can greatly modify the platform's "natural" or eigenmode EM characteristics. In 1996 the lab was funded to demonstrate the techniques to aid NAVAIR in evaluation of proposals for an EA6-B Low Band Transmitter upgrade for the ALQ-99 jammer. SEL modeling results clearly pointed to one of the proposals as the best match to the NAVAIR antenna requirements. In 1997, funding was provided by NAVAIR to assist the winning company with final designs. The SEL computer models of the winning design accurately predicted frequencies where the airframe and its appendages controlled the antenna performance, in spite of all the attempts by the design team to force a different performance. The results of the numerical analysis also enabled the manufacturer to make specific design changes that improved antenna performance over that from the original designs that won the contract.

For the first ten years of the SEL lab, the NPS mainframe IBM computer was the only computer system for numerical modeling. During those days, the amount of computer resources required to model a ship or aircraft forced staff to make use of the four NPS "academic vacation" weeks (the last two weeks in June and December). During these 24-hour days of the "computing month," 90% of the annual modeling was accomplished! Today, a typical Pentium PC can provide an order of magnitude more computation overnight. The most recent SEL efforts in antenna modeling software have resulted in the acquisition of a Navy site license for a PC-based Windows version of the Numerical Electromagnetics Code (NEC), NEC-Win PRO.

Radiowave Propagation

The lab has provided numerical analysis and experimental research in support of the Navy's requirement to site VLF through UHF communication antenna systems and support equipment in non-ideal locations since 1987. Ionospheric shortwave radiowave propagation characterization in the mid-latitudes is a mature applied science. For the regions of the earth where theoretical techniques fail due to, at present, unpredictable ionospheric anomalies, there are few tools for military communication planners. These regions are in the polar latitudes, where Doppler shift and spreading occur, affecting reception of digital signals, and in the equatorial latitudes where ionospheric scintillation affects satellite signals and geolocation accuracy.

In the initial phase of the propagation research, the SEL staff evaluated selected HF (shortwave) propagation-prediction codes and compared their answers to measured data for propagation paths in the polar regions. Also, a Doppler shift and spreading study was initiated to establish parameters that were needed for characterizing the polar ionosphere.

The Naval Information Warfare Activity (NIWA) (formerly NSG Code GX) developed the Radio Frequency Mission Planner (RFMP). RFMP provides

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SIGNAL ENHANCEMENT LAB, *continued from page 34*

the warfighter an estimate of the probability of successfully receiving and transmitting radio signals from 20 to 1500 MHz. The propagation models presently used in RFMP are tropospheric models only. But the ionosphere will also support propagation at 20 to 150 MHz in the equatorial and the polar regions of the earth. Hence in the high- and low-latitude regions, RFMP will miss ionospheric paths and not predict some possible long-distance links. Visiting Instructor **Ras Smith**, a Ph.D. candidate, developed a rule-set to add to the RFMP tropospheric models for those conditions under which auroral E-layer (Polar) and transequatorial F-layer ionospheric paths can exist. His rule-set is based on a four-year measurement campaign of polar and equatorial propagation paths. From 1990 through 1994, SEL staff, in conjunction with the SPAWAR Systems Center-San Diego (formerly NRaD) and the University of Alaska, Fairbanks, installed and operated two polar transmitting sites, one at the Arctic Submarine Lab at Cape Prince of Wales, AK, and the other at Kotzebu, AK. The equatorial sites were located at Raratonga in the Cook Islands, at Christmas Island on the geomagnetic equator and at Hilo, Hawaii.

In recent RFMP support, the SEL staff has conducted a littoral propagation measurement experiment to provide measured data for comparison to RFMP propagation algorithms. The efforts involved the preparation of a radio-noise-quiet instrumentation van and the installation of an automated RF signal collection system in the van. A companion 6-band automated VHF-UHF transmitter system was installed onboard the US Coast Guard Cutter *Long Island* for two measurement campaigns and onboard the research vessel *Point Sur* during the summer and fall 1997. Data was collected along the coastal plains and in the coastal mountain range system from Santa Cruz to below Big Sur, as well as several inland valleys in San Benito, Santa Clara, Santa Cruz, and Monterey counties. Data reduction and summary reports are in preparation.

Special Tasks

The Signal Enhancement Laboratory tackles other unusual problems. An example is a problem encountered by the Department of Oceanography at NPS. They purchased a variable-speed motor controller to control the position of acoustic sensors in a large water tank. Electrical noise from the variable-speed controller completely disrupted the operation of the data links and data processing system for the sensors. It also produced significant levels of radio noise. Requests for assistance from the manufacturer of the motor controller did not resolve the problem. Shielding and filtering techniques in accordance with information in outdated handbooks did not solve the problem.

Staff members of the Signal Enhancement Laboratory examined the problem and quickly devised effective and inexpensive mitigation actions. These actions were implemented and the system has been operating without problems for several months. The same techniques are being used to reduce electrical noise problems in receiving sites and data-processing centers.

RADIO FREQUENCY MISSION PLANNER (RFMP)

RFMP is a tactical decision aid used to place communications, intelligence collection, and information warfare assets within the battlespace. Similarly, it assists in determining the vulnerability of friendly RF emissions to hostile exploitation, and in battlespace frequency management and deconfliction.

RFMP is operational at a growing number of U.S. Navy field sites as well as aboard aircraft carriers and flagships on deployment. It is currently the only tactical decision-aid (modeling tool) for these purposes undergoing certification under the SECNAV review process conducted by CNMOC. RFMP is also undergoing certification to be the RF modeling and planning tool for the Global Command and Control System (GCCS) - Maritime. It will be available throughout the fleet via the GCCS (JMCIS) LAN.

For virtually any area worldwide, RFMP provides a highly visual and interactive display of how signals from 100 kHz to 3 GHz (with extensions through 30 GHz) propagate throughout the area of interest. It differs from other propagation tools in that it selects from a catalog of models based on frequency, the effects of terrain, weather (troposphere and space), and environment characteristics. RFMP also incorporates real transmitter/receiver/antenna parameters.

For the first time for the USN decision maker, RFMP is then able to calculate critical decision parameters, such as:

- the probability of acquiring the signal of interest,
- the probability of your signal being detected, and
- the probability of maintaining a particular signal-to-noise ratio.

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CISR, *continued from page 5*

participate in courses and engage in collaborative research. The program helps accelerate technology transfer between academe and industry. Visiting professors participate in NPS CISR programs for periods from a month to a year.

Invited Lectures. The Invited Lecture Series injects commercial and military relevance into the NPS CISR activities. Leading experts in the field of computer science and INFOSEC from government, academe, and industry address the students, staff, and faculty. A few of the invited lecturers are: Dr. Roger Schell, Novell; Dr. Paul Karger, IBM; Dr. John McLean, Naval Research Laboratory; Dr. Thomas Berson, Anagram Laboratories; and Terry Benzel, Trusted Information Systems.

Academic Outreach. Academic outreach permits other, non-CISR academic institutions to benefit from the education and research developments at NPS. For the past two years NPS CISR has sponsored the Workshop on Education in Computer Security (WECS). Attended by participants from Europe and North America, WECS has provided educators with an opportunity to hear from government and industry, and discuss educational requirements, develop strategies for academic programs, and share pedagogical material. NPS CISR has prepared material for dissemination to those needing a jump-start into computer security teaching. A CD with complete class notes has been very popular as is the NPS CISR web site at http://cisr.nps.navy.mil/. The invited lecture series is video taped for later distribution.

Graduates. An effort to insure that NPS graduates involved in NPS CISR courses and research are recognized so that their expertise can be applied to the wide variety of INFOSEC challenges in DoD and the U.S. Government is best achieved by making appropriate organizations aware of the growing talent pool of computer security savvy students and graduates emerging from NPS CISR. Currently, the expertise of our students is being used at DISA, Fleet Information Warfare Center, SPAWAR, NSA, and many other commands.

Research. DoD has long been involved in the development of secure systems and NPS was active in computer security research as early as 1978, well before the topic became highly visible.The rapid evolution of networking within DoD and DoN has lead to the connection of most computer systems to LANs and the use of WANs for data transport. Security mechanisms have lagged efforts at interconnection and now leave these systems vulnerable to exploitation by adversaries attempting either to compromise information within the systems or deny access to the systems themselves. Security for systems that must process both classified and unclassified information is an underlying theme of the diverse NPS CISR research.

Students from many NPS curricula including: Information Technology Management, C4I, and Information Warfare, join those in Computer Science to conduct thesis research with NPS CISR faculty. Research has included the following information assurance and computer and network security topics: protocols and mechanisms to improve the security of Internet Protocol (IP) over Asynchronous Transfer Mode (ATM) networks; utilization of system mechanisms to provide security for applications in heterogeneous distributed environments; issues associated with

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RADIO FREQUENCY PLANNER, *continued from page 35*

The NPS Ph.D. dissertation of **CDR Gus Lott**, currently an Assistant Professor in the Department of Electrical and Computer Engineering, played an important role in the development of the RFMP. The heart of this new view into the RF space is the "Lott Plot." Developed by CDR Lott, this visualization technique displays the joint signal and noise probability density. The user can manipulate physical parameters to see how the "probabilities" vary. After leaving NPS and serving as Chief Engineer of the Naval Information Warfare Activity, CDR Lott took his research into application development.

RFMP is making the next step with the development of a more generalized Electromagnetic Propagation Server (EMPS). Under this concept, a large host of propagation models provides service on the GCCS LAN for any user application. Again, the "Lott Plot" becomes the fundamental method for determining the decision-maker's metric.

RFMP is available at NPS on a local TAC-4 HP UNIX workstation. For more information on RFMP, persons interested can see a demonstration at: http://www.arlut.utexas.edu/~rfmpwww/public_page/rfmp_home/.

CISR, *continued from page 36*

security and quality of service; examination of signature identification mechanisms for malicious software, such as viruses; network intrusion detection and response; high assurance techniques for the creation of execution domains; utilization of existing high assurance multilevel products in near-term architectures to achieve operational multilevel secure network solutions; analysis of products which could be used to enhance the protection of sensitive but unclassified information; and the development of DoD-relevant strategies for the analysis of software security products.

A problem for DoD systems includes not only the provision of control of access to and movement of data based on fixed sensitivity levels, but the preservation of compatibility with commercial-off-the-shelf (COTS) application software as well. When compatibility with COTS applications takes precedence, often each access class is relegated to an independent system-high enclave and sharing is achieved through: manual, "sneaker-net" techniques; automated guards for which no notion of sufficiency or completeness with respect to security policy enforcement can be demonstrated; or replication systems relying on physical separation. All can be costly in terms of space, equipment and administration. NPS CISR faculty, staff, and students are constructing a COTS-driven Local Area Network that will provide multilevel secure (MLS) services to users while permitting them to employ standard office productivity tools on standard workstations. The ongoing development centers on the provision of multilevel mail and messaging to the desktop.

Increasingly, ATM is being used in DoN networks and techniques to move IP traffic over ATM networks are being explored. Unfortunately, current proposed standards for the transport of IP packets over ATM networks are silent regarding packet security. Faculty and students are examining techniques to provide security for IP traffic in ATM networks. Two areas are being investigated: the design of a network access controller to support IP over ATM seamlessly while preventing the flow of unauthorized information from a secure enclave; and investigation of a security protocol and mechanism for fast IP packet forwarding at the data link layer.

Defense in Depth, the DoN approach to network security, will use network intrusion detection tools. The concept of an intrusion detection system based upon the use of autonomous agents has been proposed. Deployable in heterogeneous environments, agents would be configurable to their execution environment.

Participating in a project that has as a goal quality of service for end-to-end applications in a highly dynamic environment, NPS CISR faculty, staff, and students are examining techniques to provide security for core services as well as for applications. A layered application architecture has been developed that builds upon notions of least privilege and separation of duty. A second aspect of this work is to treat processing for security as a factor in overall quality of service delivered by the system. This work will help to parameterize security choices.

NPS CISR research is funded by the National Security Agency, the Naval Security Group, SPAWAR, and DARPA. The NPS CISR members include Assistant Professor **Cynthia Irvine**, Associate Professor **Bert Lundy**, Visiting Associate Professor **Bret Michael**, Associate Professor **Neil Rowe**, Associate Professor **Tim Shimeall**, Associate Professor **Dennis Volpano**, Lecturer **Daniel Warren**, and Assistant Professor **Geoff Xie** of the Department of Computer Science, and Professor **Hal Fredricksen**, of the Department of Mathematics.

MBCORC, *continued from page 18*

programmatic relationship. "Crescent" evokes the arc of the Monterey Bay rim as well as the growing and emerging character of the institutions.

Initial signatories to the agreement were the California State University, Monterey Bay, Monterey Bay Aquarium, Monterey Bay Aquarium Research Institute, Monterey Institute of International Studies, Moss Landing Laboratories, University of California, Santa Cruz, University of California, MBEST Center, and the Naval Postgraduate School. Future parties to the agreement, in official or ex-officio status, include NOAA, the Naval Research Laboratory-Monterey, Fleet Numerical Meteorology and Oceanography Center, and the Monterey Advanced Technology Education Center of Monterey Peninsula College.

RESEARCH RECOGNITION

CONGRATULATIONS TO NPS FACULTY

Congratulations are extended to the following faculty for their promotion and/or tenure this year. **Robert Ashton**, Department of Electrical and Computer Engineering, **Isaac Kaminer**, Department of Aeronautics and Astronautics, **Knox Millsaps**, Department of Mechanical Engineering, **Glenn Robinson**, Department of National Security Affairs, **I. Michael Ross**, Department of Aeronautics and Astronautics, and **Natalie Webb**, Defense Resource Management Institute have been promoted to Associate Professor with tenure. **Peter Chu**, Department of Oceanography, **Joshua Gordis**, Department of Mechanical Engineering, **Gordon McCormick**, SOLIC Academic Committee, and **David Pratt** have been awarded tenure. Faculty promoted to Professor include **Tony Ciavarelli** of the School of Aviation Safety, **Ching-Sang Chiu** of the Department of Oceanography, and **R. Kevin Wood** of the Department of Operations Research. **Pat Harr** of the Department of Meteorology and **Leslie Rosenfeld**, Department of Oceanography, were promoted to Research Associate Professor. **Steve Hurst** and **Larry Vaughan** from the Defense Resource Management Institute have been promoted to Senior Lecturer.

RESEARCH RECOGNITION, *continued from page 28*

Warfare Analysis), Assistant Professor **Todd Weatherford** (Department of Electrical and Computer Engineering), Professor **Brij Agrawal** (Department of Aeronautics and Astronautics), RADM Chaplin, Assistant Professor **Fariba Fahroo** (Department of Mathematics), Assistant Professor **Cynthia Irvine** (Information Warfare Academic Group), Professor **Patricia Jacobs** and Distinguished Professor **Donald Gaver** (Department of Operations Research), Assistant Professor **Andres Larraza** (Department of Physics). From left to right, second row: Distinguished Professor David Netzer, Professor **Ken Thomas** (Department of Systems Management), Assistant Professor **Glenn Robinson** (Department of National Security Affairs), Associate Professor **Douglas Fouts** (Department of Electrical and Computer Engineering), Professor **Larry Jones** (Department of Systems Management), Associate Professor **Joshua Gordis** (Department of Mechanical Engineering), Associate Professor **John J. Arquilla** (Command, Control and Communications Academic Group), and Professor **Robert Haney** (Department of Meteorology). Also recognized, but not pictured are Professor **Michael Zyda** (Department of Computer Science) and Professor **James Wilson** (Undersea Warfare Academic Group).

SPAWAR FELLOWSHIPS, *continued from page 26*

SATCOM architecture. The high cost of these space systems requires a rigorous evaluation of proposed concepts before system acquisition is begun. The cost vs. capability decision should be a negotiated trade between war fighter needs and SATCOM systems costs. Accurately defining and articulating user needs and performance measures that reflect these needs are critical components of this decision process. The focus of this research is the development of a wideband system evaluation template using an industry-accepted method for the identification and development of appropriate measures of performance and effectiveness. It is anticipated that the recently established Naval Commercial SATCOM Integrated Product Team (COMMERIPT) will be one of the users of this template.

Gary Stone, a Ph.D. candidate from the National Security Agency, working with Associate Professor **Bert Lundy** of the Department of Computer Science and Mr. Mike Harrison of SSC-SD Communications and Information Systems Department, proposes to develop a tool that will characterize unknown computer communications, storing these characteristics so that if seen again on the network, the protocol can be recognized. Today there are protocol analyzers that can recognize the identity of captured computer protocol stacks. This is done by exploiting the information given in protocol specifications or the Protocol Data Unit (PDU) being used. This research will: 1) analyze captured network PDS so that common protocol fields can be identified and/or repeated fields can be recognized; 2) create a Protocol Description Language (PDL) that can represent the identified PDU in a format that the computer can use for recognition; 3) create a user friendly interface that will aid an analyst in building a protocol profile; and 4) create a procedure to process this unknown protocol. This procedure can be automated enough such that little, if any, human intervention is necessary.

CONFERENCES

Conferences/Meetings at the Naval Postgraduate School

Date	Title	Sponsor
17-22 May 98	Review of the Air Force Office of Scientific Research (AFOSR) Research Programs in Molecular Dynamics and High Energy Density Matter	Air Force Office of Scientific Research
01-04 Jun 98	11th Multinational Conference on Theater Missile Defense (SECRET)	AIAA with Ballistic Missile Defense Organization
11-12 Jun 98	Year-of-the-Ocean Conference	Oceanographer of the Navy and the National Oceanic and Atmospheric Administration.
22-26 Jun 98	Military Operations Research Society (MORS) Symposium (SECRET)	Office of the Chief of Naval Operations
29 Jun-2 Jul 98	Command and Control Research and Technology Symposium (UNCLAS)	National Defense University for the Deputy Assistant Secretary for Defense (C3I)
27-30 Jul 98	12th Annual Ada Software Engineering Education Team (ASEET Symmposium (SECRET)	Defense Information Systems Agency
17-20 Aug 98	Low Observable and Countermeasures Complementary Capabilities for Aircraft Survivability (SECRET)	Air Force Research Laboratory
17-19 Nov 98	1998 AIAA Missile Sciences Conference (SECRET)	AIAA with Office of the Undersecretary of Defense (Acquisition and Technology)
8-11 Feb 99	4th National Turbine Engineer HCF Conference (UNCLAS)	Naval Air Systems Command, Co-sponsors: Navy, Air Force, and Universal Tech Corp of Dayton

For additional information, please contact the NPS Conference Coordinator, Elaine Christian, at (408) 656-2426 or e-mail echristian@nps.navy.mil

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